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CONDITION SURVEY OF LOCK NO. 2 MONONGAHELA RIVER

by

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19 ABSTRACT (Continue on reverse if necessary and identify by block number)

A condition survey was performed at Locks and Dam No. 2 on the Monongahela River in Pennsylvania to determine the extent of possible concrete damage, processes causing distress of the concrete, selected physical and mechanical properties of the concrete and foundation materials, and the ability of the concrete to perform satisfactorily under anticipated conditions of future service. The field investigation included a visual inspection or the structure to determine the general condition of the concrete, and drilling operations to recover concrete and foundation core. Results of the field investigation and laboratory tests indicated that the concrete is generally in good condition, with dissolutioning of carbonate aggregate particles giving the appearance of exposed aggregate to the concrete. Some popouts, scaling, and spalling are also present. The near surface concrete contains some cracking not associated with any apparent chemical reaction. The cracks do not appear to be active. The concrete in this structure should remain serviceable for a period of 50 years from the date of this investigation.

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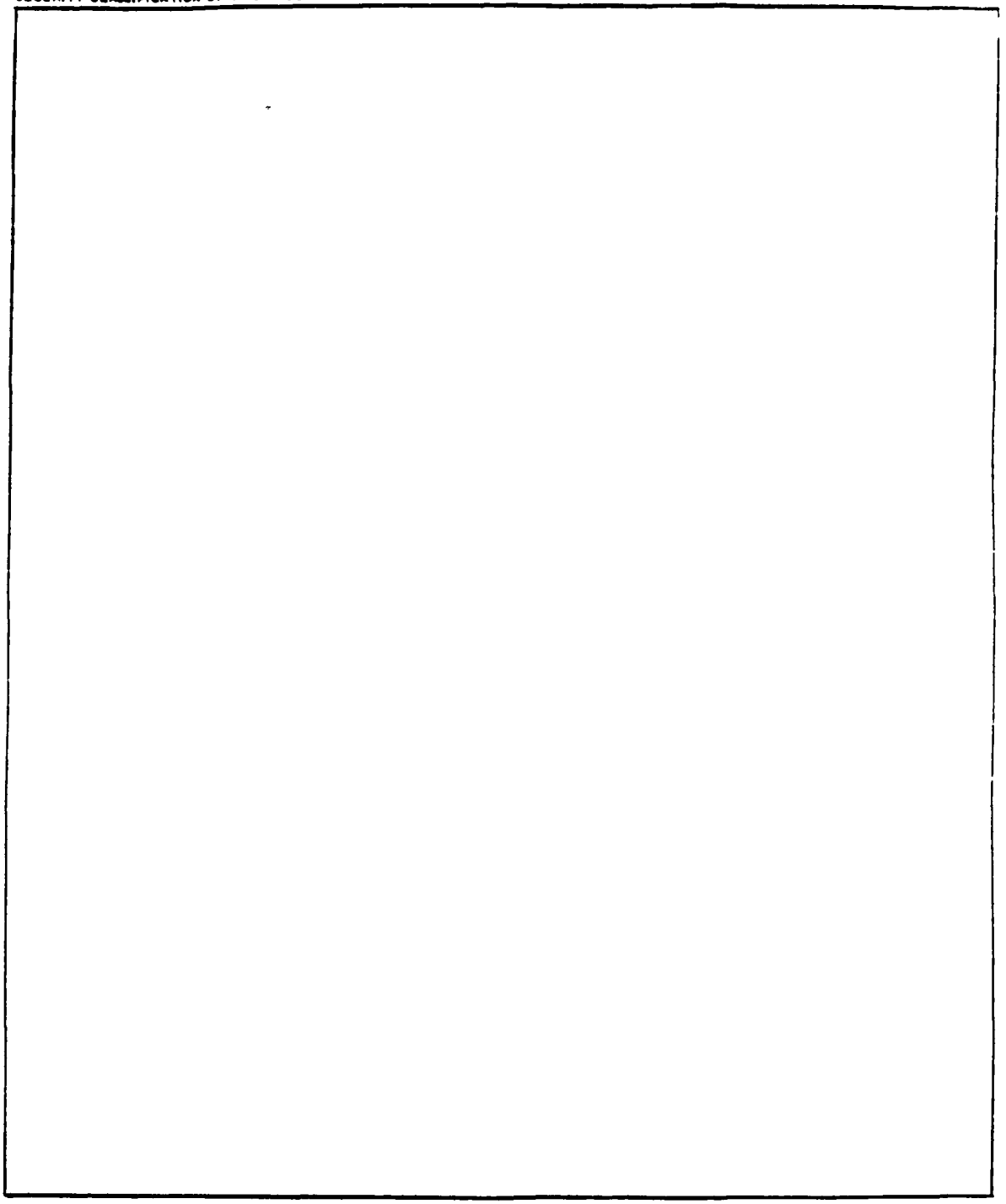

PREFACE

The work described in this report was performed for the US Army Engineer District, Pittsburgh, by personnel of the US Army Engineer Waterways Experiment Station (WES). The work was authorized by DA Form 2544, No. ORPED-85-31, dated 16 May 1985.

The testing program was accomplished under the direction of Bryant Mather, Chief, Structures Laboratory (SL), WES, and Mr. John M. Scanlon, Jr., former Chief, Concrete Technology Division (CTD), and Mr. Ken Saucier, Chief, CTD. All of the core drilling was conducted by WES under the direction of Mr. Mark A. Vispi, Chief, Exploration Group. Laboratory work in the CTD was done with the assistance of Mr. Joe G. Tom, Mrs. Joyce C. Ahlvin, and Mr. J. Pete Burkes. This report was prepared by Messrs. Wong and Stowe with assistance from Mrs. Ahlvin and Mr. Tom.

COL Dwayne G. Lee, CE, is the Commander and Director of WES. Dr. Robert W. Whalin is Technical Director.

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EXHIBIT 1: PHOTOGRAPHIC RECORD OF DRILLED CORE*

* On file with US Army Engineer District, Pittsburgh.

CONVERSION FACTORS, NON-SI TO SI (METRIC)
UNITS OF MEASUREMENT

Non-SI units of measurement used in this report an be converted to SI (metric) units as follows:

Multiply	By	To Obtain
degrees (angle)	0.1745329	radians
feet	0.3048	metres
feet per second	0.3048	metres per second
inches	25.4	millimetres
miles (US statute)	1.609344	kilometres
pounds (force) per square inch	0.006894757	megapascals
pounds (mass) per cubic foot	16.01846	kilograms per cubic metre
tons (force) per square foot	0.09576052	megapascals

CONDITION SURVEY OF LOCK NO. 2
MONONGAHELA RIVER

PART I: INTRODUCTION

Project Description

1. The following description of the project is taken from the first periodic inspection report of Locks and Dam 2 (US Army Engineer District, Pittsburgh, 1973). Locks and Dam 2 are located on the right bank of the Monongahela River 11.2 miles* above the mouth at Pittsburgh (Plate 1). The dam is a fixed crest weir with crest at elevation 718.7; the dam is part of the original structure constructed between 1902-1906. Of the existing locks, the 56-ft by 360-ft riverward lock was reconstructed riverward of the original locks and completed in 1951 using the original landward chamber to maintain traffic. The 110-ft by 720-ft landward chamber was constructed after completion of the new riverward chamber which was used to maintain traffic and was completed in 1953. A general plan view and cross-sectional view of the locks are presented in Plate 2. This plate is also taken from the first periodic inspection report.

Background

2. The Waterways Experiment Station (WES) was requested by the US Army Engineer District, Pittsburgh (ORP for Ohio River, Pittsburgh), to conduct a condition survey at Lock and Dam No. 2. The ORP provided design, construction, operation and maintenance information and data on the structures. The First Periodic Inspection Report dated 25 August 1973 and the Second Periodic Inspection Report dated 15-16 June 1978 were reviewed for information pertinent to the concrete. The survey consisted of a site inspection to determine the general condition of the concrete and to locate borings. Following the site visit, it was recommended that a crack survey not be performed at this time due to the relatively good condition of the concrete and the lack of

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* A table of factor for converting non-SI units of measurement to SI (metric) units is presented on page 4.

cracking. The drilling program was approved by the District while some of the boring locations were approved during the drilling operation.

Objective

3. All efforts were limited to locks structure. The condition survey of the much older dam was not part of this effort. The dam is submerged at all times and did not lend itself to a detailed condition survey without major efforts to dewater the structure. The dam will be addressed by the District. The objectives of the condition survey are: (a) Identify the processes or materials causing distress or failure of the concrete and the probable extent of such damage, (b) determine the ability of the concrete to perform satisfactorily under anticipated conditions of future service, and (c) determine selected physical and mechanical properties of the foundation and associated materials as they relate to possible stability analysis of the structure. The District would perform a stability analysis if necessary.

Scope

4. This report presents: (a) The drilling effort involved in recovering samples of concrete, foundation rock, and backfill material associated with the project, and (b) the physical condition and extent of damage of in-place concrete using visual, petrographic and physical property information and data. Selected physical properties of core samples were determined using standard Corps of Engineers test methods.

PART II: PRELIMINARY STUDY

5. A WES geologist made a brief inspection of the lock structure to determine the general condition of the concrete* in the different elements of the lock and select boring locations. The guide walls, guard walls, and the lock walls were inspected for signs of concrete deterioration with special emphasis on cracking and possible chemical attack and aggregate reaction.

6. There was no intent during this initial inspection to provide details of where cracking occurred or specifically locating areas of distress in the structure. If a crack survey and surface mapping were thought necessary, such work was to be proposed. As a result of this preliminary inspection, it was determined that no further documentation of the concrete condition was necessary.

7. The lock crew provide a work barge to allow closer observation of the concrete within the lock chamber both at the upper and lower pool elevations. While on the barge, the upper and lower guide walls and the river side of the river lock wall were inspected.

Esplanade

8. The concrete is generally in good condition with the individual panels intact. Some relative displacement of panels is evident. The surfaces of the panels are similar in appearance to that of the mass concrete with some exposure of coarse limestone aggregate. Fifty percent aggregate exposure is evident in many of the panels.

Upper Guide Wall

9. The backfill from monolith 15 to monolith 24 is below the top of the guide wall while the backfill from monolith 25 to monolith 29 is above the top of the wall as it is for the rest of the guide wall. It is grassed and shows no signs of any depressions (Figure 1). There are fine-to-medium transverse cracks* at one-third points between the monolith joints. Surface

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* See ref American Concrete Institute Committee 201, 1980, for definition of terms associated with the durability of concrete.

Figure 1. Grassed area behind upper guide wall

deterioration on the top of the wall is limited to exposure of the limestone coarse aggregate with approximately 15 percent of the surface affected.

10. The river face is armored from the service bridge for the emergency dam to the upstream end of the wall. The concrete is intact and only shows light weathering. There is some light scaling along the monolith joints.

Land Wall

11. Horizontal surface. The concrete on this surface is in good condition with approximately 15 percent of the surface displaying signs of aggregate dissolution in which the aggregate appears etched as the paste remains standing in relief. Short fine-to-medium cracks are found associated with structural features such as openings in the concrete and mooring pins.

12. River face. The surface is generally in good condition. Below the upper pool elevation there is some minor spalling of the monolith joints. Surface above the upper pool shows 20 percent exposed aggregate and small joint spalls (Figure 2).

13. Gate recesses. The upper gate recess has been refaced, and the concrete is in good condition. There is some cracking of the concrete around

Figure 2. River face of the land wall, large chamber

a recent concrete repair running diagonally from the pintle area near the opening winch recess. The concrete in the lower gate recess is similar to that in the upper gate recess. Some hairline cracks are present on the gate recess face below the gate machinery recess floor line.

Lower Guide Wall

14. The concrete is uniform along the entire wall. The concrete is in good condition with apparent solution of the crushed limestone coarse aggregate leaving the paste in relief. Some medium-to-fine transverse cracks are present in the monoliths. Alignment of the monoliths is good. Vegetation is growing from the joints on top and on the vertical faces in the settling basin for U.S. Steel Corp.

Middle Wall

15. Horizontal surface. The exposure of the limestone coarse aggregate was more pronounced than that of the land wall with an estimated 30 percent of the surface exposed (Figure 3). Popouts on the surface concrete were sometimes numerous (Figure 4) which lends some additional evidence to the possibility of

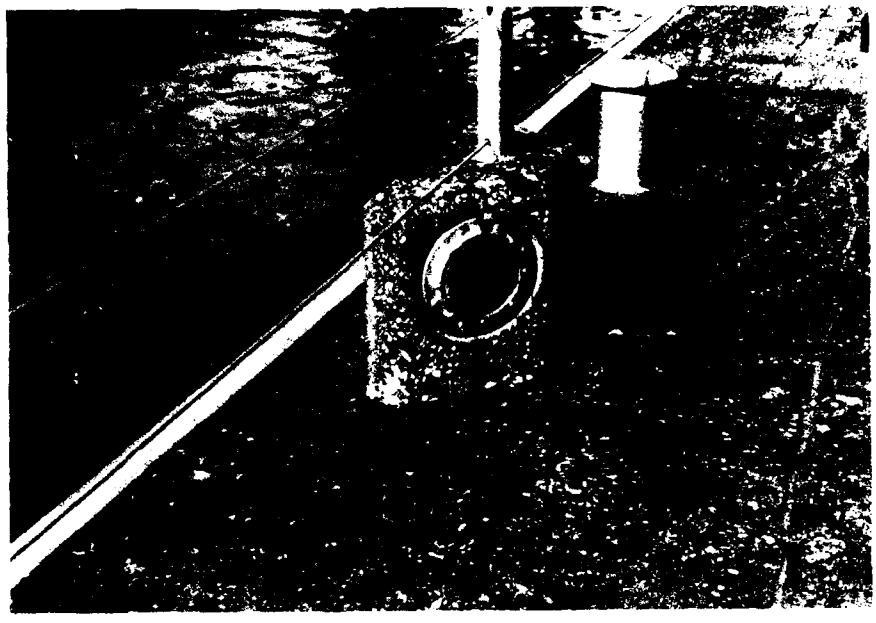

Figure 3. Solution of coarse aggregate particles gives an exposed aggregate appearance to the concrete

Figure 4. Pop-outs caused by nondurable aggregate particles

some low durability aggregate as "D" cracking was observed at monolith joint M-20/M-19 and monolith joint M-22/M-23 as well as around machinery openings in monoliths M-24 and M-25. Cracking of the concrete in monolith M-3 around the lock crane support was evident. Pattern cracking was present in many of the monoliths such as in monoliths 12, 16, and 19. The joint on the river side of monoliths M-24/M-25 was severely cracked with some indicated displacement.

16. Land face. The concrete above upper pool elevation is in good condition. The concrete below the upper pool elevation contained approximately 5 percent severely scaled concrete and approximately 30 percent lightly-scaled concrete. Severe spalling was present along the monolith joints (Figure 5).

17. Gate recesses, large lock. The upper-gate recess concrete is in good condition with little weathering. The joints are as cast. The concrete in monolith M-5 in the vicinity of the opening winch is severely scaled with efflorescence outlining numerous cracks contained in localized areas. The lower gate recess has some spalling of the concrete with some concrete in the process of falling off. In general, the concrete is in good condition.

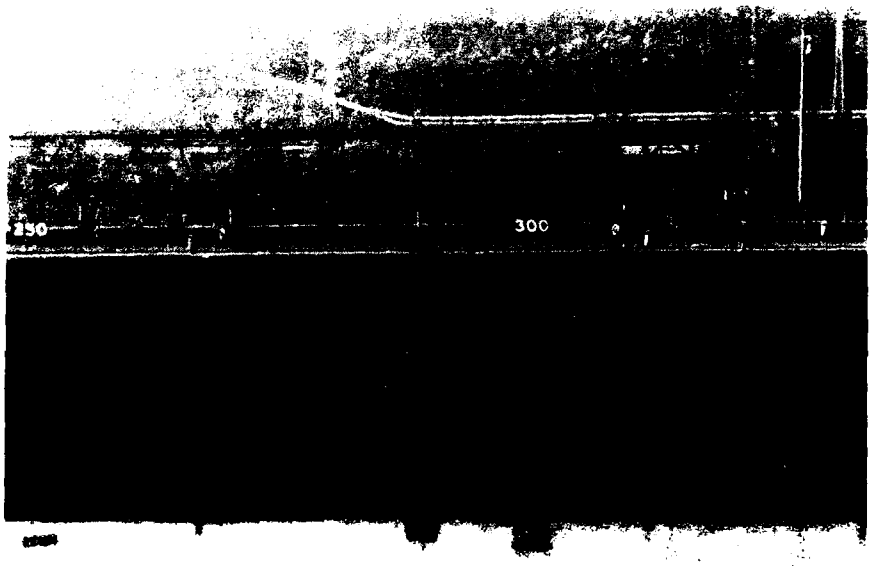

Figure 5. Severe spalling along monolith joints in land face of middle wall

18. River face. The concrete above the upper pool elevation contains some medium scaling affecting 75 percent of the area. Some small spalls are

evident along joints below the upper pool elevation. There is some spalling between upper and lower pool elevations, but generally the concrete is in good condition.

19. Gate recesses, small lock. Some scaling is evident in the concrete especially below the upper pool elevation where 80 percent of the area is affected. Some cracking was observed near the corners of grated openings associated with the gate machinery. Minor spalling was observed.

River Wall

20. Horizontal surface. The concrete has an exposed aggregate appearance with 30 percent of the concrete affected. Seventy percent of the concrete surface is slightly eroded with some popouts. There are many incipient hairline cracks along the edge armor. The corners of the monoliths show signs of "D" cracking, but the surface concrete is generally in good condition.

21. Land face. Above the upper pool elevation, the concrete is generally in good condition. Ten percent of the surface has an exposed aggregate appearance. Some iron staining is present. The armor is in good condition and is in intimate contact with the concrete. The joints above the upper pool elevation are as cast while the monolith joints below upper pool elevation are commonly spalled especially in the non-armored areas. Ten percent of the surface is scaled below the upper pool elevation.

Upper Guard Wall

22. Cracking is common around the light posts. Exposed aggregate is visible over 30 percent of the surface. Some minor popouts are present, and fine healed hairline cracks parallel the corner armor. The land-wall face is armored from the upper gate recess to monolith No. 1. Exposed aggregate is evident for about the upper 2 ft of concrete and affect approximately 15 percent of the area. The concrete below 2 ft is in good condition.

Lower Guard Wall

23. Lower guard wall. The land face is armored from the lower gate to the downstream end of the wall and is in good condition. There is some slight

spalling of the joints generally near the lower pool elevation. About 15 percent of the surface has an exposed aggregate appearance. Efflorescence is present in the upper 1 ft of monoliths R-24 and R-29 through R-31. Cracking of the upper surface is present in monoliths R-29 through R-31. Severe scaling is present in 2 percent of monolith R-30.

PART III: DRILLING OPERATION

24. Following the on-site inspection, a drilling plan was formulated to investigate the different qualities of concrete represented in the lock walls, Plate 3. The requirements to obtain foundation samples for purposes of evaluating the foundation condition and conducting physical property tests were considered in locating the concrete borings. The borings were distributed as follows:

Location	Number of Borings	Core Size, in.	Depth, ft Vertical	Depth, ft Horizontal	Remarks
Upper guide wall	1	4	10		Concrete
Land wall	3	6	80		Backfill & rock (omitted one)
Land wall	2	6		3	Concrete
Land wall	2	6	10		Concrete (R-17 Extended)
Lower guide wall	1	6	10		Concrete
Middle wall	2	6	80		Concrete & rock
Middle wall	4	6		3	Concrete
Upper guard wall	1	6	10		Concrete
River wall	1	6	10		Concrete (omitted)
River wall	1	6	80		Concrete & rock
River wall	2	6		3	Concrete
Lower guard wall	1	6		3*	Concrete
Lower guard wall	1	6	10		Concrete

* Inclined.

25. This plan was modified during the drilling program to accommodate unanticipated adverse drilling conditions and logistics in setting up at

several boring locations. One alternate boring was drilled (BR WES L-7A)* as a 5-in. (i.d.) steel pipe was intersected at approximately 5.4 ft. Two scheduled borings, L-8 into the backfill and foundation rock and R-2 adjacent to the service crane on the river wall, were not drilled because of logistics problems. Proposed boring L-8 was one of 3 borings into the backfill and foundation rock. There were difficulties encountered in drilling backfill borings L-2 and L-5; i.e. slag, silt, mud, sandstone boulders, brick and pieces of steel were frequently encountered in an unconsolidated state. Because it was difficult to drill and obtain samples of such a variety of materials, it was decided that the third boring would not be drilled. However, boring L-7A in the land wall was extended to include the foundation rock representing the downstream portion of the lock.

26. The drilling plan consisted of 21 borings with 8 horizontal borings into the lock walls, one inclined boring into the lower guard wall, and 12 vertical borings into the lock and backfill with six of the vertical borings going into foundation rock. Pertinent information concerning the boring number, depth of hole, core size, direction of boring, elevation top of hole, elevation top of rock, and elevation bottom of boring is presented in Table 1. General boring locations are illustrated in Plate 3; detailed locations are illustrated in the field logs, Appendix B.

27. WES provided two drill crews for the field operation. Two geologists from WES and one from the Pittsburgh District were present during the drilling. All concrete and foundation material were logged by the field geologists. Photographs were made of all cores soon after the cores were removed from the core barrel (Exhibit 1).

28. The drill crews and equipment arrived at Locks and Dam No. 2 on 18 October 1985. The district provided barge and crane support in moving the drill rigs from L/D No. 4 where a drilling program had just been completed.

29. Equipment used during this project included: a Failing 1500 truck mounted rig used to drill all the vertical borings on the land wall and into the backfill, an Acker skid rig and a Failing Model 43-6A skid rig used to drill the deep holes in the middle wall and river wall, and a KOR-IT

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* Boring designation: BR for the town of Braddock in which the project is located; WES for the drilling agency; L-7A for land wall, number of boring and A for alternate boring. All other references to borings will be done using the wall designation letter and number of the boring.

Series K-100 portable rig used to drill the horizontal holes and vertical borings not accessible using the skid rigs or the truck-mounted rig.

30. The lockmaster provided a work flat for the drill crews to operate equipment while drilling the horizontal borings within the lock chambers. The vertical position of the work flat was positioned by raising and lowering the pool level within the lock chamber. Anchor bolts were placed into the concrete and held the drill to the wall during the drilling operation (Figure 6).

Figure 6.

31. The split-spoon samples were collected, placed, and sealed in 6 x 12-in. plastic concrete cylinder molds. The rock cores were wrapped and waxed to protect the core and prevent moisture loss. The cores were then placed in wooden core boxes and readied for shipment to WES. The concrete cores were put into wooden core boxes to prevent damage during transportation. All rock cores, concrete cores, and samples placed in the cylinder molds were shipped to WES for examination and testing.

32. Drill Manufacturers Association standard 6 x 7 3/4-in. and 4 x 5-in. double tube swivel tub core barrel was used with diamond bits to obtain the concrete and bedrock core in vertical borings. A single tube core barrel

with a diamond bit was used to take the horizontal cores and some of the shallow vertical cores.

33. Borings into the backfill were filled by allowing the surrounding material to slough when the casing was removed. All holes resulting from concrete borings were filled using a prepackaged concrete. The horizontal holes were filled with a relatively dry mixture while the vertical holes were filled using a more workable mixture of the same material.

34. Concrete core recovery was 100 percent for all concrete cores except one. A short interval in boring R-5 at approximately 55-ft depth was ground up during the drilling operation and was removed from the core barrel in fragments. The rock recovery was good for all cores into the foundation with an average recovery of 94 percent. Only 80 percent of the rock in boring L-5 was recovered while recovery in the other borings ranged from 92 to 99 percent.

35. Samples of backfill material were taken every 5 feet. The material ranged from loosely consolidated slag particles to zones of clay silt material (Figures 7 and 8). Approximately 115 ft of backfill was drilled and sampled, much of it required casing to prevent sloughing of adjacent material. A total of 328.8 ft of concrete core and 185.95 ft of foundation rock was cored.

36. The drilling program was completed 18 February 1986. During this field operation several days were lost due to subfreezing temperatures in which the wind chill factor went as low as -40°F. Other delays included two work stoppages due to flooding of the lock structure (Figure 9), once from 27 November through 29 November 1985 and once from 5 February through 7 February 1986.

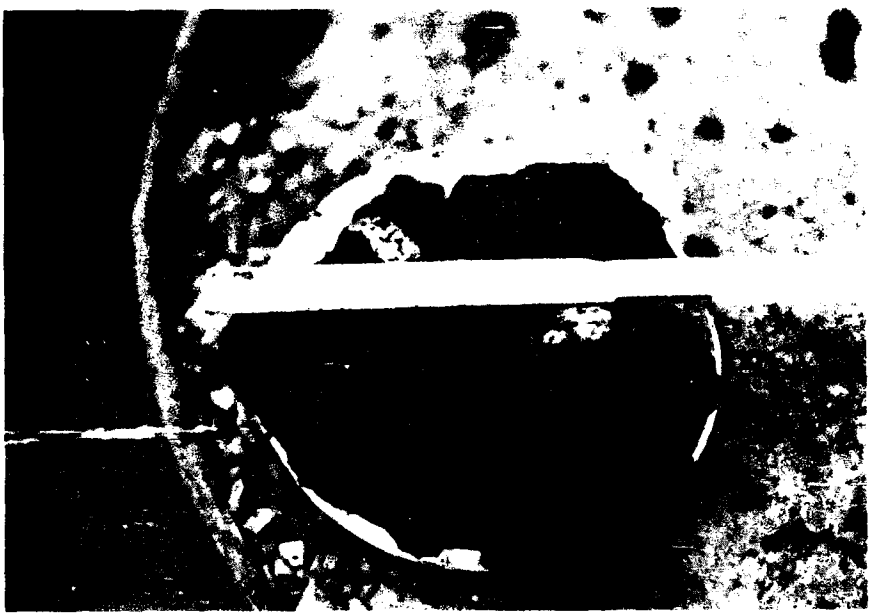

Figure 7.

Figure 8.

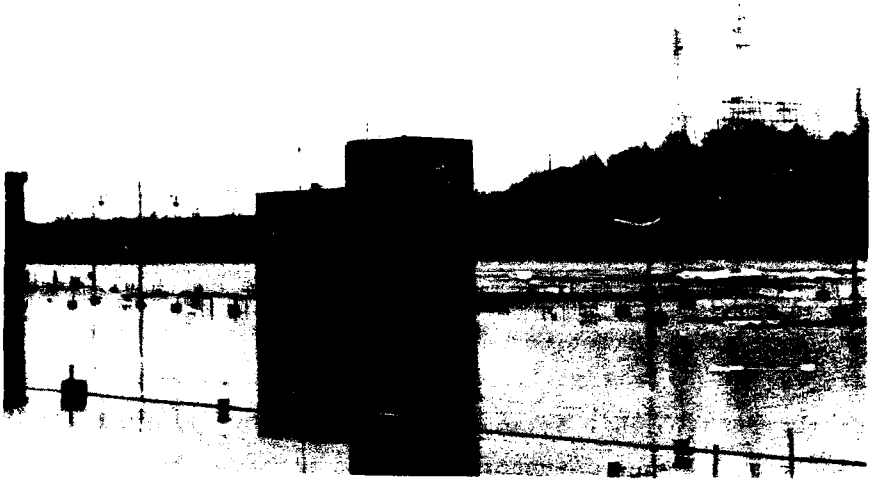

Figure 9.

PART IV: GEOLOGY

37. The lock site geology is taken from the Periodic Inspection and Continuing Evaluation of Completed Civil Works and Structures "Monongahela Lock and Dam No. 2, Monongahela River, Pennsylvania First Periodic Inspection Report, 28 August 1973."

38. The basin of the Monongahela River is located in the Allegheny Plateau province and is carved out of gently folded shales, sandstones, thin limestones, and coals of the Carboniferous system. The basin is essentially a dissected plateau in which are developed in varying degrees the Schooly, Harrisburg and Worthington peneplains. The land slopes are steep except on a few terraces and relatively narrow flood plains within the main valley. The bedrock encountered in the borings belong to the middle members of the Conemaugh formation of the Pennsylvania series. Underlying the alluvial fill are the basal few feet of the Upper Pittsburgh redbeds member, the thin Jane Lew sandstone, not over 3 ft thick, the Lower Pittsburgh redbeds member, a siltstone, about 40 ft thick, and the extremely fossiliferous Wood Run limestone member.

39. Six borings were made into the foundation rock during the current project. Four borings were made through concrete walls, and two borings were made through the backfill behind the land wall. The deepest rock boring was L-7A taken to elevation 611 ft. The other cores were taken to obtain approximately 20 ft of rock core from each boring and were generally to elevations near 640 ft.

40. The backfill material consisted of a variety of different materials, most of which were clay, silt and pea-size gravel. Also included were flakes of steel, pieces of brick, particles of slag, large size sandstone pieces, and chunks of steel. These materials were common to both backfill holes. The foundation rock began at elevation 667.3 ft in boring L-2 and at elevation 675.6 ft in boring L-5. Boring L-2 consisted of shale to elevation 658.5 ft where the rock became more silty to the end of the boring at elevation 646.5 ft. Boring L-5 consisted of clay shale, fractured shale, and brown shale to the end of the boring at elevation 657.3 ft. Some soft-clay shale was present in both holes at the backfill to foundation rock contact.

41. Boring L-7A was the only boring drilled in the land wall, and it went into foundation rock. The concrete to foundation interface was intact at elevation 671.6 ft (56.9-ft depth). Foundation rock consisted of clay shale

rubble, silty shale, and clay shale with slickensides evident on break surfaces. The boring went to elevation 611 ft.

42. Foundation cores were taken at the upper and lower end in the middle wall. Two borings, M-1 and M-6, through the middle wall and into the foundation rock intersected the foundation at elevations 672.15 ft and 667.1 ft. The concrete to rock contact was not intact. Boring M-1 consisted of a mixture of soft to moderately hard clay shale, red shale, gray shales, and brown clay shale while the rock in boring M-6 was generally a gray moderately hard silty shale with numerous healed fractures.

43. Boring R-5 was the only hole drilled in the river wall that intersected the foundation rock. The concrete foundation interface at elevation 663 ft was not intact as the rock fragments were in contact with the concrete. The rock was generally intact and consisted of a moderately hard sandy shale with calcareous inclusions.

44. Previous boring data indicate the foundation rocks in this area consist of indurated clays, silty clay shale, moderately hard gray clayey siltstone, and medium hard to hard gray siltstone. The current description of the foundation cores parallels the descriptions of the rocks previously cored as described in the First Periodic Inspection Report.

PART V: TEST SPECIMENS AND TEST PROCEDURES

Cores Received

45. Approximately 630 ft of core was received at the WES from 21 total borings. Twelve of these borings were vertical, ranging in depth from 1.7-ft to 119-ft, for a total of 601 ft. There were 8 horizontal borings, all of approximately 3-ft depth, totaling 25 ft of core. One inclined boring was made to a depth of 3 ft.

46. Core boxes were stored in a local warehouse near the project site for protection from the weather until the job was completed, and they were shipped to WES. All the cores were received in good condition, and no sample damage due to rough handling was detected. Once the cores arrived at the WES, they were stored inside to minimize effects of exposure to normal weathering.

47. In addition to concrete and rock cores, samples in 8 plastic bags and 24 plastic cylinders were received. These samples consisted of material recovered from the backfill area of the land wall in two holes and rubble material from bedrock in one hole. These samples were sealed to prevent loss of moisture and were also received undamaged. Pertinent information concerning the concrete and rock samples as received is presented in Table 1.

Selection of Test Specimens

48. A visual examination of all cores received was made in the laboratory to supplement the field boring logs and to assist in the selection of representative test specimens. Concrete specimens were selected for testing based upon location, depth, and physical condition. Representative properties throughout the structure could thus be obtained.

49. A total of 20 concrete specimens were selected for physical and mechanical property testing (see Table 2). These specimens represented concrete from 4 deep (35 ft +) vertical borings; representing each wall, 2 shallow vertical borings (10 to 20 ft), and 9 horizontal borings. These specimens represent all areas of each wall, including both damaged and sound concrete.

50. Nine concrete specimens were selected for petrographic examination. These specimens were selected from cores that represented the different

concrete types identified when logging in the cores. They also represented concrete from each area of each of the three lock walls.

51. Rock core specimens for both physical testing and petrographic examination were selected as best was possible from areas in close proximity to the base of the structure. All test specimens for direct shear testing were obtained within 8 ft of the concrete foundation contact; a fourth of the specimens were from within 3 ft of the contact. Each of two identifiable rock types were tested according to the availability of samples. Location of rock test specimens is indicated in the appropriate tables of test results.

52. The direct shear test specimens ranged in color and had different hardnesses. The majority of the specimens were gray shale with only 1 blue gray and three brown shales. The rock texture was similar throughout. The most noticeable difference between the specimens was hardness. Specimens were put into two groups based on whether they were soft to moderate hard or moderate hard regardless of other features such as color. None of the shale recovered contained detectable weak zones such as clay seams. Without the presence of naturally occurring potentially weak zones, selection of intact test specimens was made. Direct shear tests were conducted along horizontal bedding planes.

53. Two borings put into the backfill revealed that a predominance of waste products were placed as fill. Slag, silt, bricks, irregular pieces of steel, and sandstone boulder mixed with water made core recovery extremely difficult. Sandy clayey mud along with, and sometimes mixed with sand and gravel was recovered. Representative samples of the backfill were taken to the soils testing facility and in consultation with a soil specialist, it was decided not to attempt any soils testing. There was no structure left to the samples; and a repeated direct shear test was ruled out due to the mixed nature of the samples plus there was not any reasonable way to arrive at a moisture content and density which is required for reconstituting a repeated direct shear sample. It is thought that experience and engineering judgement available at the District could be used to approximate appropriate backfill properties for stability calculations.

Laboratory Test Program

Concrete cores

54. The testing program for the concrete cores consisted of the following:

a. Petrographic examination.

b. Unit weight, γ.

c. Velocity, V_p.

d. Compressive strength.

e. Elastic modulus, E.

f. Poisson's ratio, ν

Rock cores

55. The testing of the bedrock cores consisted of the following tests. The tests are grouped under either characterization tests or engineering design tests.

a. Characterization tests.

(1) Effective (as-received) unit weight, γ_m.

(2) Water content, w.

b. Engineering design tests.

(1) Direct shear strength, intact (peak and residual).

Test Procedures

Petrographic examination

56. The petrographic examination was performed using general guidance from "Standard Recommended Practice for Petrographic Examination of Hardened Concrete," CRD-C 57-78, ASTM C 856-77 (USAE WES, 1949). Concrete from locations where deterioration existed was examined and compared to concrete from locations where nondeteriorated concrete was recovered. This comparison provided information on types of deterioration mechanisms that acted upon the concrete and gave indication of the depth of deterioration.

57. The petrographic examination of the rock and river sediment was performed using general guidance from "Standard Practice for Petrographic Examination of Aggregates for Concrete," CRD-C 127-80 ASTM-C 295-79 (USAE WES, 1949). The river sediments were also examined visually and classified using

the "Soil Classification Chart" in "Standard Test Method for Classification of Soils for Engineering Purposes," ASTM-D 2487-69 (Reapproved 1975).

Unit weight (γ)

58. The unit weight of the concrete was determined according to "Standard Test Method for Specific Gravity, Absorption, and Voids in Hardened Concrete," CRD-C 23-84 ASTM-C 642-82 (USAE WES, 1949). The apparent specific gravity was determined for each selected test specimen. The specimens were weighed in water and in air. The unit weights were then calculated by multiplying the apparent specific gravities by 62.43 lb/ft^3.

Pulse velocity (V_p)

59. The pulse velocity was determined for the concrete according to "Standard Method of Test for Pulse Velocity Through Concrete," CRD-C 51-70 ASTM-C 597-71 (USAE WES, 1949).

Compressive strength, elastic modulus (E), and Poisson's ratio (ν)

60. The compressive strength, elastic modulus, and Poisson's ratio were determined according to "Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression," CRD-C 19-83 ASTM-C 469-81 (USAE WES, 1949). Strain gages, 2 vertical and 2 horizontal, were bonded to the specimens for purposes of measuring the axial and diametrical strains. The electrical impulses were averaged for the two orientations of strain gages to minimize the affects of core imperfections. Strength corrections were made for specimens with L/D ratios less than 1.8.

61. The characterization properties tests and the engineering design properties tests of the foundation rock were conducted in accordance with the appropriate test method tabulated below:

Property	Test Method	
	Rock	Concrete
Characterization		
Effective Unit Weight (As-Received), γ_m	RTM 109-80	
Water Content, w	RTM 106-80	
Engineering Design		
Direct Shear Strength	RTM 203-80	

PART VI: TEST RESULTS AND DISCUSSION

Petrographic Examination

62. All of the concrete examined was air entrained. The concrete consisted of two distinct mixtures one using natural river gravel for coarse aggregate and another mixture using a crushed carbonate coarse aggregate. Both concrete mixtures used a natural fine aggregate. The concrete examined in the current program is as reported in the information provided in the First Periodic Inspection of Lock and Dam No. 2. Concrete above elevation 691.75 ft consisted of a 3-in. top size crushed gravel as the principal mixture.

63. The concrete was generally in good condition and intact with little or no evidence of internal cracking. Concrete from the various parts of the structure was generally hard, dense and well consolidated. A summary of the cores examined are presented in Plates 4 thru 20. Details of the petrographic examination of the concrete are presented in composite field and laboratory logging of the cores in Appendix B and in the petrographic examination of the concrete cores as presented in Appendix C.

64. The surface of the concrete was eroded in some areas while in other areas the surface remained intact. Some of the surface concrete appeared to have been attacked chemically as the surfaces appeared etched with the siliceous aggregate remaining in relief and the carbonate coarse aggregate etched away leaving slight depressions in the concrete. Some popouts were present in the concrete. The extent of any damage to the concrete seemed to be limited to the near surface region. The following sections summarize the concrete from the different locations of the lock structure.

Concrete Quality

Guide walls

65. The preliminary study indicated that the surface concrete was limited to some dissolutioning of the surface and exposure of the coarse aggregate. Some spalling was present along the monolith joints.

66. Two vertical borings were drilled in the guide walls, one in the upper guide wall and one in the lower guide wall. Only slight weathering of the surface concrete was observed in the cores. The concrete in these cores

contained 3-in. maximum size crushed limestone aggregate. The strength of the concrete was over 5,000 psi.

67. The boring drilled into the lower guide wall also showed surface weathering with some light scaling. The near surface concrete was 0.5-in. maximum size crushed limestone coarse aggregate to 1.5-ft depth where the concrete has 3-in. maximum size crushed limestone coarse aggregate. The boring was taken along a crack. The crack extends approximately 3 ft into the concrete. No chemical nor alkali-aggregate reaction was found associated with the crack.

68. The tabulation below summarizes the depth of damaged concrete for borings into the guide walls.

Structural Element	Boring	Boring Direction		Damaged Concrete Depth, ft
		Horizontal	Vertical	
Upper guide wall	L-1		X	none
Lower guide wall	L-9		X	none

Guard walls

69. Fine healed hairline cracks were common in the surface concrete of the guard walls. The concrete was slightly eroded with an exposed aggregate appearance. Some efflorescence and scaling were also present in some monoliths.

70. Three borings were drilled into the guard walls, two vertical borings and one inclined boring. Boring R-1 drilled into the upper guard wall consisted of a mixture of crushed and natural gravel coarse aggregate. The surface of the core was intact and showed no signs of deterioration.

71. Boring R-7 was a vertical boring drilled into the lower guard wall. The surface concrete was in good condition. Compressive strength of a test specimen taken from near the top of the boring was 4,480 psi. The inclined boring taken from the river side of the lower guard wall indicated some medium to severe scaling of the concrete at the surface. The interior concrete was in good condition.

72. The tabulation below summarizes the depth of damaged concrete for borings into the guard walls.

Structural Element	Boring	Boring Direction		Damaged Concrete Depth, ft
		Horizontal	Vertical	
Upper guard wall	R-1		X	none
Lower guard wall	R-6	inclined		none
Lower guard wall	R-7		X	none

Land wall

73. Top surfaces of the land wall showed signs of aggregate dissolutioning. Fine cracks were present around structural features such as openings and mooring pins.

74. All three vertical borings into the top surface of the land wall showed only surface deterioration of the concrete with the surfaces showing light and medium scaling. The concrete was generally dense with good consolidation and contained crushed limestone coarse aggregate.

75. The compressive strength of the near surface concrete in boring L-1 was 5,990 psi. The test of interior concrete from boring L-7A indicated concrete with compressive strength of 5,790 psi.

76. Two horizontal cores were taken from the river face of the land wall, one near the upper pool level at elevation 726.5 ft (L-4) and one near lower pool level at elevation 715.5 ft (L-6). Both cores showed moderate surface weathering with some exposed aggregate at the surface. The concrete cores from both borings consisted of air-entrained concrete composed of crushed limestone coarse aggregate. Only surface damage was evident in the cores. The compressive strength of the cores were 6,770 psi for near surface concrete from boring L-4 and 4,460 psi for interior concrete at a 2-ft depth from the beginning of boring L-6.

77. The tabulation below summarizes the depth of damaged concrete for borings into the land wall:

Structural Element	Boring	Boring Direction		Damaged Concrete Depth, ft
		Horizontal	Vertical	
Land wall	L-3		X	none
Esplanade/Backfill	L-5		X	none
Land wall	L-4	X		none
Land wall	L-6	X		none

(Continued)

Structural Element	Boring	Boring Direction		Damaged Concrete Depth, ft
		Horizontal	Vertical	
Land wall	L-7		X	none
Land wall	L-7A		X	none

Middle wall

78. Appearance of the concrete in the middle wall was similar to that in the land wall. Additionally, the concrete in the middle wall contained numerous popouts at times and also had some "D" cracking along some monolith joints indicating that some low durability aggregate was used in the concrete.

79. Two vertical borings were drilled into the top surface of the middle wall. Borings M-1 and M-6 consisted of concrete with a 1-in. maximum size aggregate to one foot depth. The remainder of the concrete for both holes to the full depth of the concrete contained 3-in. maximum size coarse aggregate. Only slight surface deterioration was present in the cores recovered from this lock wall.

80. Tests of near surface concrete and interior concrete indicated the concrete to have compressive strengths of over 6,000 psi. The near surface concrete with the smaller aggregate had strengths of 7,130 psi and 7,840 psi. The interior concrete had strengths of 6,480 psi, 6,950 psi, and 7,810 psi.

81. Concrete from the land face of the middle wall was similar to the concrete from the river face of the middle wall as described in the Preliminary Study section of this report. Scaling of the surface was the most common deficiency. Borings M-2 and M-5 were drilled into the land face with M-2 near the lower pool elevation at 717.1 ft and M-5 near the upper pool elevation at 723.9 ft. The surfaces appeared to have been eroded due to abrasion and dissolutioning. Cracking of the concrete at 0.1 ft below the surface in boring M-2 indicated depth of deteriorated concrete was more than only surficial.

82. Two borings made into the river face of the middle wall were made at elevations 716.3 ft and 725.3 ft for borings M-3 and M-4, respectively. Both cores consisted of air-entrained concrete composed of 4-in. maximum size coarse aggregate. Only surface deterioration of the concrete in the form of scaling was observed.

83. Compressive strengths determined for the concrete in both land and river faces of the middle wall were above 6,000 psi.

84. The tabulation below summarizes the depth of damaged concrete for borings into the middle wall:

Structural Element	Boring	Boring Direction		Damaged Concrete Depth, ft
		Horizontal	Vertical	
Middle wall	M-1		X	none
Middle wall	M-2	X		none
Middle wall	M-3	X		0.1
Middle wall	M-4	X		none
Middle wall	M-5	X		none
Middle wall	M-6		X	none

River wall

85. Light scaling was the major deficiency in the concrete from the river wall. The concrete was represented by one vertical boring the full depth of the concrete, boring R-5, and two borings into the land face drilled in the small lock chamber. Those borings were at elevations 725.3 ft and 715.0 ft for borings R-3 and R-4, respectively.

86. Concrete from boring R-5 contained 2.5-in. maximum size natural coarse aggregate throughout the length of the core which was unlike the other vertical cores taken in the other walls in which the upper foot consisted of concrete made using a smaller coarse aggregate. The concrete was intact, air entrained, and in good condition. Strengths determined for the concrete were 5,890 psi for the near surface concrete and 6,400 psi and 4,500 psi for interior concrete.

87. Boring R-3 was drilled near a monolith joint and a lift joint. The boring intersected some reinforcing steel at approximately 0.8-ft depth. The steel was in good condition. The surface concrete was slightly weathered with some medium scaling. Interior concrete was intact, contained 3-in. maximum size natural coarse aggregate, and was air entrained.

88. Boring R-4, representing concrete at the lower pool elevation, was slightly more eroded and weathered than the concrete in the upper pool elevation. However, the interior concrete was similar to the upper pool elevation concrete consisting of intact air-entrained concrete with 3-in. maximum size natural coarse aggregate. The concrete strengths determined for the upper and lower pool elevation concrete were 6,830 psi and 6,550 psi, respectively.

89. The tabulation below summarizes the depth of damaged concrete for borings into the river wall:

Structural Element	Boring	Boring Direction		Damaged Concrete Depth, ft
		Horizontal	Vertical	
River wall	R-3	X		none
River wall	R-4	X		none
River wall	R-5		X	none

90. The physical properties of the concrete are tabulated in Table 3. The unit weight of the concrete ranged from a low of 142.4 lb/ft^3 to 151.9 lb/ft^3. The average was 147.0 lb/ft^3.

91. The pulse velocity of the concrete ranged from 13,486 ft/sec to 16,652 ft/sec. The average pulse velocity for this concrete was 15,125 ft/sec. Lower pulse velocities of 13,486 ft/sec, 13,801 ft/sec, and 13,912 ft/sec correlated with concrete having strengths of 4,480 psi, 4,500 psi, and 5,790 psi, respectively, which were some of the lower strength concrete measured. Two cores, one from boring L-1 and on from L-4 had strengths of 5,360 psi and 4,460 psi, respectively, which had pulse velocities above 16,000 ft/sec.

92. The compressive strength of the concrete was generally over 5,500 psi with only 3 of the 20 specimens tested below this figure. All strengths were above 4,500 psi with the average compressive strength for both interior concrete and exterior concrete at 6,190 psi. There was no significant difference between strengths of concrete from near the surface and concrete in the interior of the structure.

93. The principal concrete mixtures used in the construction of the lock walls were a 4-bag mixture using 3-in. nominal maximum size crushed gravel and a 5-bag mixture using 1 1/2-in. top size crushed gravel. The 28-day compressive strengths for the mixtures were 4,314 psi and 5,637 psi, respectively. The average strength of the concrete is above the 28-day strengths reported for the mixtures used in the lock wall construction.

94. The data for the Poisson's ratio and modulus of elasticity are presented in Table 3. The stress-strain curves are presented in Plates 33 to 38. Average Poisson's ratio for the concrete tested was 0.24 for the

specimens tested. Poisson's ratio ranged from 0.16 to 0.29. The average modulus of elasticity was 4.0×10^6 psi.

Peak and Residual Shear Strength

95. A limited number of intact shale specimens were tested for shear strength parameters. A summary of the direct shear test results, density, and water content of foundation core is presented in Table 4. The rock core was divided into two groups based upon hardness. A moderately hard shale, and a soft to moderately hard shale were identified.

96. The shear stress versus shear deformation and the normal versus shear deformation curves are presented in Plates 21 thru 34. Shear stress versus normal stress plots were drawn up for the two groups of rocks. The shear strengths obtained from the soft to moderate hard rocks plotted reasonable well considering the scatter in shear strength at a given normal load; an angle of internal friction for peak strengths (ϕp) and cohesion (C) was calculated and is 51.9° and 5.4 psi respectively. The residual shear angle (ϕr) for the soft to moderate hard rocks was calculated and is 25.0° with a C = 2.1 psi. Shear strength parameters were calculated by the method of linear regression.

97. When the peak shear strengths obtained from the moderately hard rocks were potted, there was a wide scatter in the shear strengths for a given normal load. This indicates a variation between specimens which is probably due to differences in hardness between specimens within this group. The residual shear strength values plotted much closer together than did the peak shear strengths indicating relative consistency in this lower bound strength parameter.

98. After studying the similarity in the shape of the shear stress versus shear deformation curves, the specimen densities and moisture contents, and the peak and residual shear strengths, it was decided to plot all the shear test results together, and calculate a peak and residual failure envelope for all specimens. It was thought that the foundation rock within 8 ft of the concrete-foundation interface would be better represented by doing this. In making the calculation of shear strength parameters for both groups of rocks, a few data points were thrown out because they were widely scattered from the majority of the other data points. In other words the few data

points were thrown out because they were believed to belong to another rock population.

99. The stress stress versus normal stress plot for the two groups or rocks is presented in Figure 10. The peak shear strength parameters are, for the angle of internal friction (Øp) and cohesion (C), 47.5° and 6.4 psi respectively. The residual shear strength parameters are 25.8° and 1.32 psi respectively for Øp and C. These shear strength values are thought to be representative of the foundation rock in close proximity to the founding elevation of the lock walls.

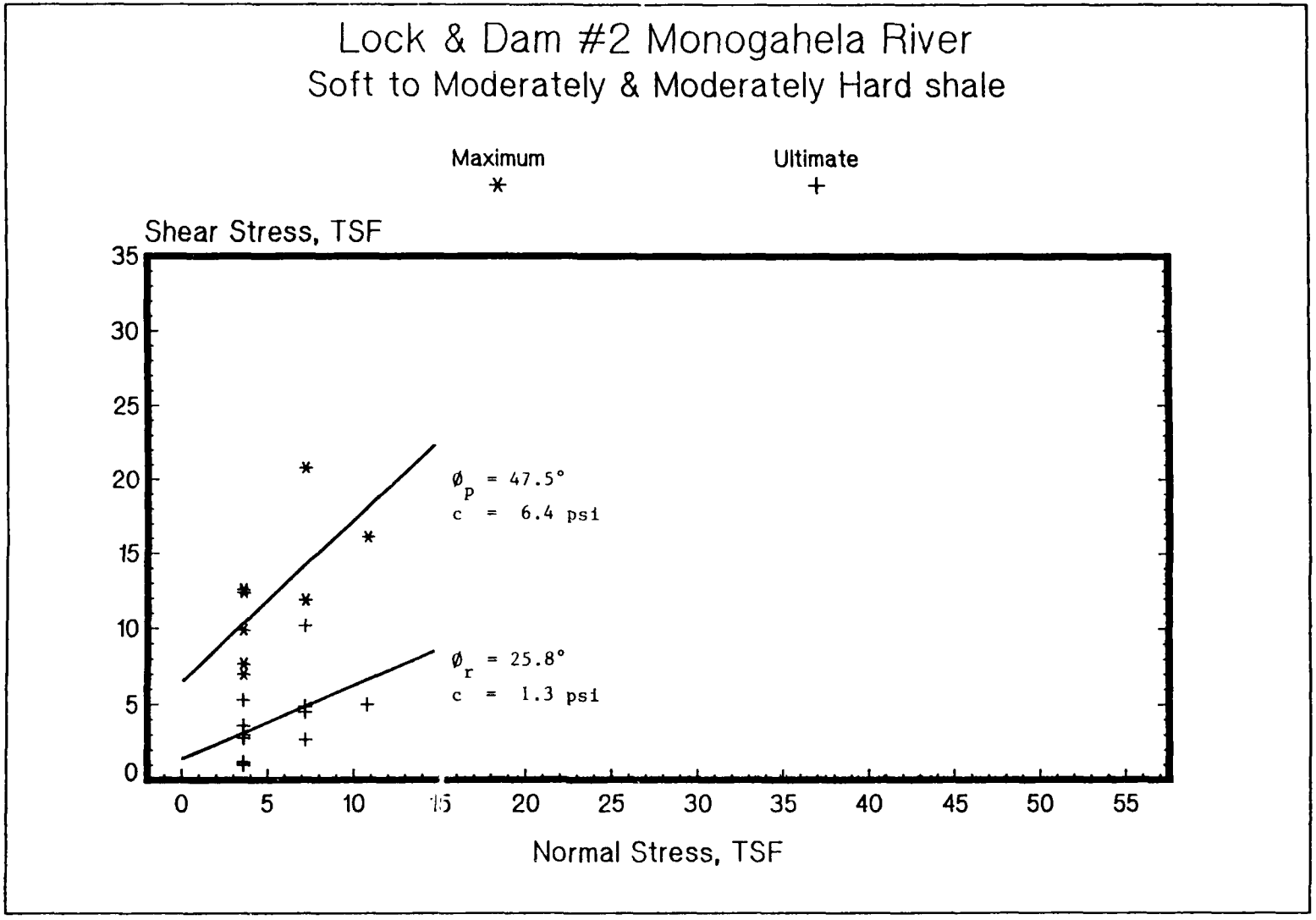

Figure 10. Failure envelopes for foundation rock

PART VII: CONCLUSIONS AND SUMMARY

100. The concrete at Locks and Dam No. 2 making up the lock walls, the guide walls, and guard walls is in fair to good condition. All of the concrete is air entrained which has protected the concrete from any major freeze-thaw damage. Some surface scaling is evident in most of the concrete, but the original surface is generally recognizable.

101. Dissolutioning of the limestone coarse aggregate is evident throughout the entire lock structure. The aggregate is partially dissolved thus weakening the support of the thin surface mortar which has eventually eroded away causing the concrete to have an exposed aggregate appearance. The phenomenon is widespread but is confined to the surface of the concrete and has not caused any deep penetrating damage to the concrete.

102. During the construction of the lock, the majority of the concrete was a 4-bag mixture using 3-in. maximum size coarse aggregate and then topped with a 5-bag mixture using 1 1/2-in. maximum size coarse aggregate. Both concretes were found to be in good condition, and interface between the two concretes was generally intact.

103. The steel armor has protected the guide walls, the guard walls, and the lock walls from abrasion due to the river traffic. The concrete associated with the armoring is in good condition.

104. Some "D" cracking was present along the monolith joints, but the cracks appeared healed. Hairline cracks were also common along the steel-edged plates along the river wall and the guard walls. These hairline cracks do not appear to be active.

105. Popouts are common on some of the surfaces. This indicates that some of the aggregate used in the construction was low-durability aggregate. Popouts are surface features and will not affect the internal integrity of the concrete.

106. Vertical cracking was present on the top of the guide walls at periodic intervals and was not associated with any apparent chemical reaction and did not appear to be active. The cracks may have been due to original shrinkage of the concrete.

107. Some vertical monolith joints have spalled. Borings made adjacent to these areas have indicated that the depth of deterioration is confined to

the visible spalled concrete. No damage due to the interior cracking was evident in the cores examined from these areas.

108. Some minor repairs have been made in the gate machinery area. The repaired concrete is generally in good condition. Some cracking of the concrete was noted in the vicinity of some of the operating winches. The concrete from borings adjacent to these areas indicates that the concrete is intact and in good condition.

109. The near surface concrete shows only minor surface deficiency. While at the present these surface defects are not currently a maintenance problem, as normal weathering progresses, the concrete surface will continue to deteriorate as it has in the past, which is essentially none at all. Vertical and horizontal core showed no signs of deterioration, and the exterior concrete has not deteriorated since construction.

110. The shale recovered from the lock wall foundation did not contain weak zones such as clay seams, therefore, intact specimens were tested in direct shear parallel to bedding. Two groups of shale were identified and tested separately. For the analysis of the direct shear strength parameters, the groups were combined due to similarities in the shear stress versus shear deformation curves and similarity of other key rock properties. The peak shear strength parameters are $\phi p = 47.5°$ and $C = 6.4$ psi. The residual strength values are $\phi r = 25.8°$ and $C = 1.32$ psi.

PART VIII: PROJECTED CONCRETE CONDITION

111. No major deteriorating mechanism was recognized in the laboratory investigation that was likely to degrade the concrete at the locks during the next 50 years.

112. The concrete surfaces, both vertical and horizontal, showed no sign of deterioration beyond normal weathering since construction, therefore a rate of deterioration was not calculated for Locks and Dam No. 2. Some cracking of the horizontal and vertical concrete surfaces was evident, however. These cracks, along with possible cracks in the galleries and the emptying and filling culverts, should be mapped for future reference. The concrete should remain in serviceable condition for a period extending on the order of 50 years from the date of this investigation.

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Table 1

Pertinent Boring Information

Boring No. BR WES	Depth of Hole, ft	Core Size, in.	Direction of Boring	Elev Top of Boring, ft	Elev Top of Rock, ft	Elev Bottom of Boring, ft
L-1	10.55	6	V	730.5	---	719.95
L-2	80.5	4	V	727.5	667.8	647.0
L-3	16.1	6	V	732.5	---	716.4
L-4	3.2	6	H	715.5	---	---
L-5	73.2	6	V	730.5	675.6	657.3
L-6	2.55	6	H	726.5	---	---
L-7	6.5	6	V	730.5	---	724.0
L-7A	119.5	6	V	730.5	671.6	611.0
L-9	10.65	6	V	730.5	---	719.85
M-1	97.1	6	V	732.5	672.2	635.4
M-2	3.2	6	H	717.1	---	---
M-3	3.2	6	H	716.3	---	---
M-4	2.9	6	H	725.3	---	---
M-5	3.3	6	H	723.9	---	---
M-6	91.7	6	V	732.5	667.1	640.8
R-1	1.6	6	V	730.5	---	728.9
R-3	3.1	6	H	725.3	---	---
R-4	3.1	6	H	715.0	---	---
R-5	90.7	6	V	730.5	663.0	639.8
R-6	3.3	6	I	715.5	---	---
R-7	3.0	6	V	730.5	---	727.5

Table 2

Core Received at WES from Locks and Dam No. 2, Monongahela River

Structures Lab I.D.	Field I.D.	Location	Core Dia, in.	Material	Boxes
Pitts-13 CON-1 to CON-4	BR WES L-1	U.S. End of Guide Wall	6	Concrete	4
Pitts-13 DC-1, to DC-18	BR WES L-2	U.S. Land Wall Backfill	5,2 1/2 4	Backfill & Rock	18
Pitts-13 CON-5 to CON-9	BR WES L-3	U.S. Land Wall Gate Recess	6	Concrete	5
Pitts-13 CON-10	BR WES L-4	Land Wall Lower Pool	6	Concrete	1
Pitts-13 CON-11	BR WES L-5	Land Wall	6	Concrete	1
DC-19 to DC-33		Esplanade	2 1/2	Backfill	5,12*
Pitts-13 CON-12	BR WES L-6	Land Wall Upper Pool	6	Concrete	1
Pitts-13 CON-13 to CON-15	BR WES L-7	D.S. Land Wall	6	Concrete	3
Pitts-13 CON-16 to CON-35	BR WES L-7A	D.S. Land Wall	6	Concrete	20
DC-34 to DC-53				Rock	40
Pitts-13 CON-36 to CON-39	BR WES L-9	D.S. Guide Wall	6	Concrete	4
Pitts-13 CON-40 to CON-59	BR WES M-1	U.S. River Wall Gate Recess	6	Concrete	20
DC-54 to DC-65			6	Rock	12
Pitts-13 CON-60	BR WES M-2	U.S. Middle Wall Land Face	6	Concrete	1
Pitts-13 CON-61	BR WES M-3	Middle Wall River Face	6	Concrete	1
Pitts-13 CON-62	BR WES M-4	Middle Wall River Face	6	Concrete	1
Pitts-13 CON-63	BR WES M-5	D.S. Middle Wall Land Face	6	Concrete	1
Pitts-13 CON-64 to CON-86	BR WES M-6	D.S. Middle Wall	6	Concrete	23
DC-66 to DC-75			6	Rock	10
Pitts-13 CON-110	BR WES R-1	U.S. Guard Wall	6	Concrete	1
Pitts-13 CON-111	BR WES R-3	U.S. River Wall Land Face	6	Concrete	1
Pitts-13 CON-112	BR WES R-4	River Wall Land Face	6	Concrete	1
Pitts-13 CON-87 to CON-109	BR WES R-5	D.S. River Face Gate Recess	6	Concrete	23
DC-76 to DC-84			6	Rock	9
Pitts-13 CON-114	BR WES R-7	D.S. Guard Wall	6	Concrete	1

* Plastic cylinders.

Table 3

Concrete and Rock Core Test Results Locks and Dam No. 2, Monongahela River

CTD Specimen No.	BR WES Boring No.	Direction of Boring	Core Depth, ft	Dia., in.	Length, in.	Unit Weight, pcf	Pulse Velocity, fps	Comp Strength, psi	Elastic Modulus x 10^6 psi	Poisson's Ratio
Pitts-13										
CON-1	L-1	V	0.00- 3.15	5.94	12.25	150.7	16,366	5,360	4.9	0.21
CON-5	L-3	V	0.00- 3.75	5.95	12.35	151.9	16,129	5,990		
CON-10	L-4	H	0.00- 3.15	5.90	12.40	150.6	16,652	4,460		
CON-12	L-6	H	0.00- 2.55	5.90	12.50	149.0	15,755	6,770		
CON-29	L-7A	V	39.50-43.10	5.94	12.25	146.4	13,912	5,790	3.0	0.16
CON-40	M-1	V	0.00- 2.30	5.95	12.40	149.0	15,349	7,840		
CON-51	M-1	V	32.60-35.75	5.94	12.25	147.4	14,875	6,480	4.2	0.26
CON-61	M-3	H	0.00- 3.15	5.90	12.25	145.2	14,925	6,020	4.4	0.29
CON-62	M-4	H	0.00- 2.95	5.85	12.35	147.8	15,487	6,440		
CON-63	M-5	H	0.00- 3.30	5.88	12.30	146.7	15,282	6,560		
CON-64	M-6	V	0.00- 2.30	5.90	11.80	145.6	15,105	7,130		
CON-74	M-6	V	26.20-28.90	5.90	12.25	145.2	14,705	6,950		
CON-86	M-6	V	61.10-63.30	5.92	12.30	145.1	14,309	7,810		
CON-110	R-1	V	0.00- 1.65	5.83	12.25	143.5	13,486	4,480	2.9	0.25
CON-111	R-3	H	0.00- 3.10	5.88	12.35	148.3	15,487	6,830		
CON-112	R-4	H	0.00- 3.10	5.90	12.25	147.5	15,994	6,550	4.5	0.24
CON-87	R-5	V	16.10-19.20	5.88	12.35	144.1	14,492	5,890		
CON-97	R-5	V	35.00-	5.90	12.40	146.7	15,755	6,400		
CON-109	R-5	V	60.40-63.40	5.95	12.35	142.4	13,801	4,500		
CON-113	R-6	I	0.00- 3.30	5.88	12.40	146.1	14,925	5,520		
					$\bar{X}$	147.0	15,125	6,190	4.0	0.24
					SD	2.5	875	980	0.8	0.05
					n	20	20	20	6	6

Table 4

Lock and Dam No. 2, Mon River

Summary Direct-Shear Test Results

Hardness	Boring No. BR WES	Depth ft	Density pcf	Water Content %	Normal Stress tsf	Maximum Shear Stress tsf	Residual Shear Stress tsf	Color
Soft to Mod Hard	L-2	63.9-64.2	166.1	--	3.6	7.7	3.0	Brown
	M-1	60.4-60.6	166.7	1.0	7.2	44.6	10.2	Gray
	M-1	64.1-64.5	166.1	1.7	10.8	16.1	5.0	Gray
	M-1	64.5-64.8	166.7	1.8	3.6	12.4	5.3	Gray
	M-1	65.5-65.7	166.7	1.9	3.6	7.0	3.6	Gray
	M-1	65.7-66.0	166.7	1.7	7.2	20.8	4.9	Gray
	L-7A	65.7-66.0	166.1	2.4	3.6	9.9	1.0	Gray
Moderately Hard	L-5	65.8-66.0	159.8	--	3.6	12.6	3.0	Blue Gray
	M-1	69.2-69.4	163.6	3.5	7.2	11.9	2.7	Brown
	M-1	71.1-71.5	166.7	2.4	3.6	17.3	1.2	Brown
	M-6	66.9-67.3	166.1	2.3	3.6	19.5	2.8	Gray
	M-6	74.9-75.1	167.3	1.3	3.6	27.0	4.0	Gray
	R-5	67.7-68.0	166.1	1.8	7.2	24.0	4.5	Gray
	R-5	68.6-69.0	167.9	1.5	10.8	44.8	16.5	Gray
Mean			165.5	1.9				
Standard Deviation			2.5	0.6				
Number of Specimens			17.0	12.0				

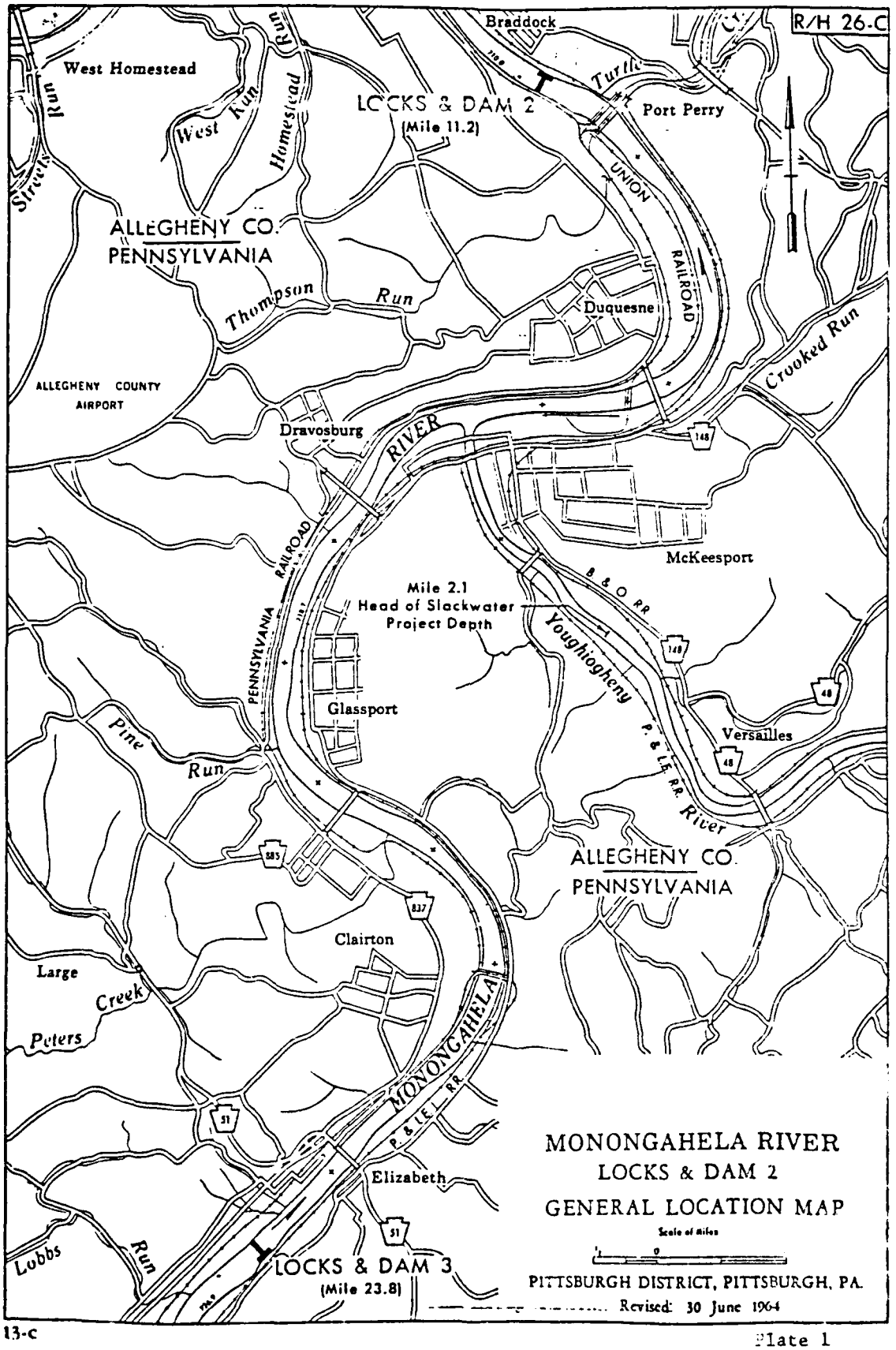

R/H 26-C
Braddock
West Homestead
Run
Streets
West Run
Homestead
LOCKS & DAM 2
(Mile 11.2)
Turtle
Port Perry
UNION
RAILROAD
ALLEGHENY CO.
PENNSYLVANIA
Thompson Run
Duquesne
Crooked Run
ALLEGHENY COUNTY
AIRPORT
Dravosburg
RIVER
148
McKeesport
PENNSYLVANIA RAILROAD
Mile 2.1
Head of Slackwater
Project Depth
B & O RR
Youghiogheny
148
48
Glassport
Pine Run
Versailles
P. & L.E. RR.
River
885
837
ALLEGHENY CO.
PENNSYLVANIA
Clairton
Large Creek
Peters
MONONGAHELA
P & L E RR
51
Elizabeth
Lubbs Run
LOCKS & DAM 3
(Mile 23.8)
MONONGAHELA RIVER
LOCKS & DAM 2
GENERAL LOCATION MAP
Scale of Miles
0
PITTSBURGH DISTRICT, PITTSBURGH, PA.
Revised: 30 June 1964

Plate 1

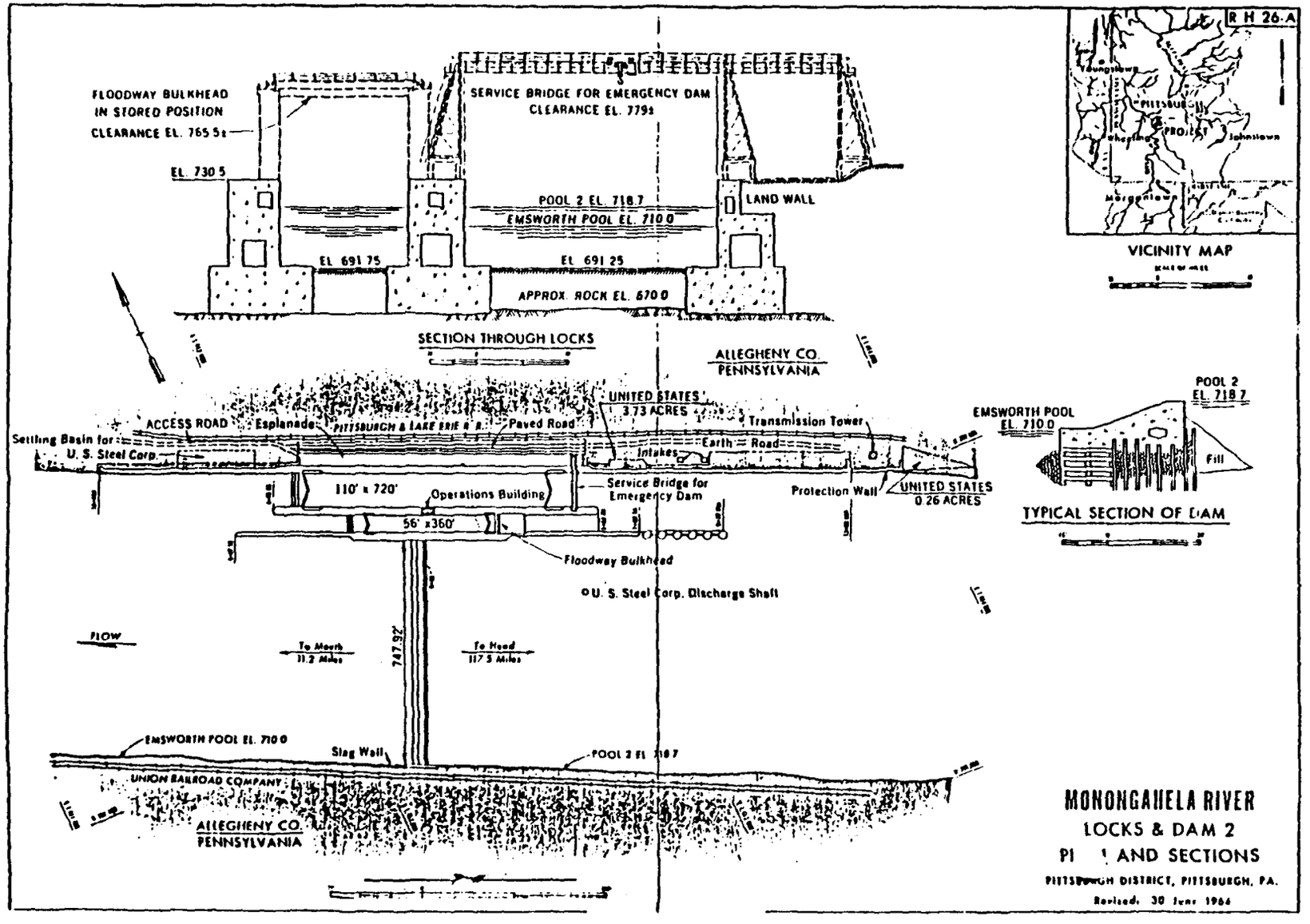

R H 26-A
VICINITY MAP
FLOODWAY BULKHEAD
IN STORED POSITION
CLEARANCE EL. 765 5±
SERVICE BRIDGE FOR EMERGENCY DAM
CLEARANCE EL. 779±
EL. 730 5
POOL 2 EL. 718 7
EMSWORTH POOL EL. 710 0
LAND WALL
EL. 691 75
EL. 691 25
APPROX. ROCK EL. 670 0
SECTION THROUGH LOCKS
ALLEGHENY CO.
PENNSYLVANIA
UNITED STATES
3.73 ACRES
ACCESS ROAD
Esplanade
PITTSBURGH & LAKE ERIE R. R.
Paved Road
Transmission Tower
Settling Basin for
U. S. Steel Corp.
Intakes
Earth Road
110' x 720'
Operations Building
Service Bridge for
Emergency Dam
Protection Wall
UNITED STATES
0.26 ACRES
56' x 360'
Floodway Bulkhead
U. S. Steel Corp. Discharge Shaft
FLOW
To Mouth
11.2 Miles
To Head
117.5 Miles
747.92'
EMSWORTH POOL EL. 710 0
Slag Wall
POOL 2 EL. 718 7
UNION RAILROAD COMPANY
ALLEGHENY CO.
PENNSYLVANIA
POOL 2
EL. 718 7
EMSWORTH POOL
EL. 710 0
Fill
TYPICAL SECTION OF DAM
MONONGAHELA RIVER
LOCKS & DAM 2
PLAN AND SECTIONS
PITTSBURGH DISTRICT, PITTSBURGH, PA.
Revised 30 June 1964

Plate 2

MONONGAHELA RIVER, LOCKS AND DAM NO. 2

BORING LOCATION PLAN VIEW

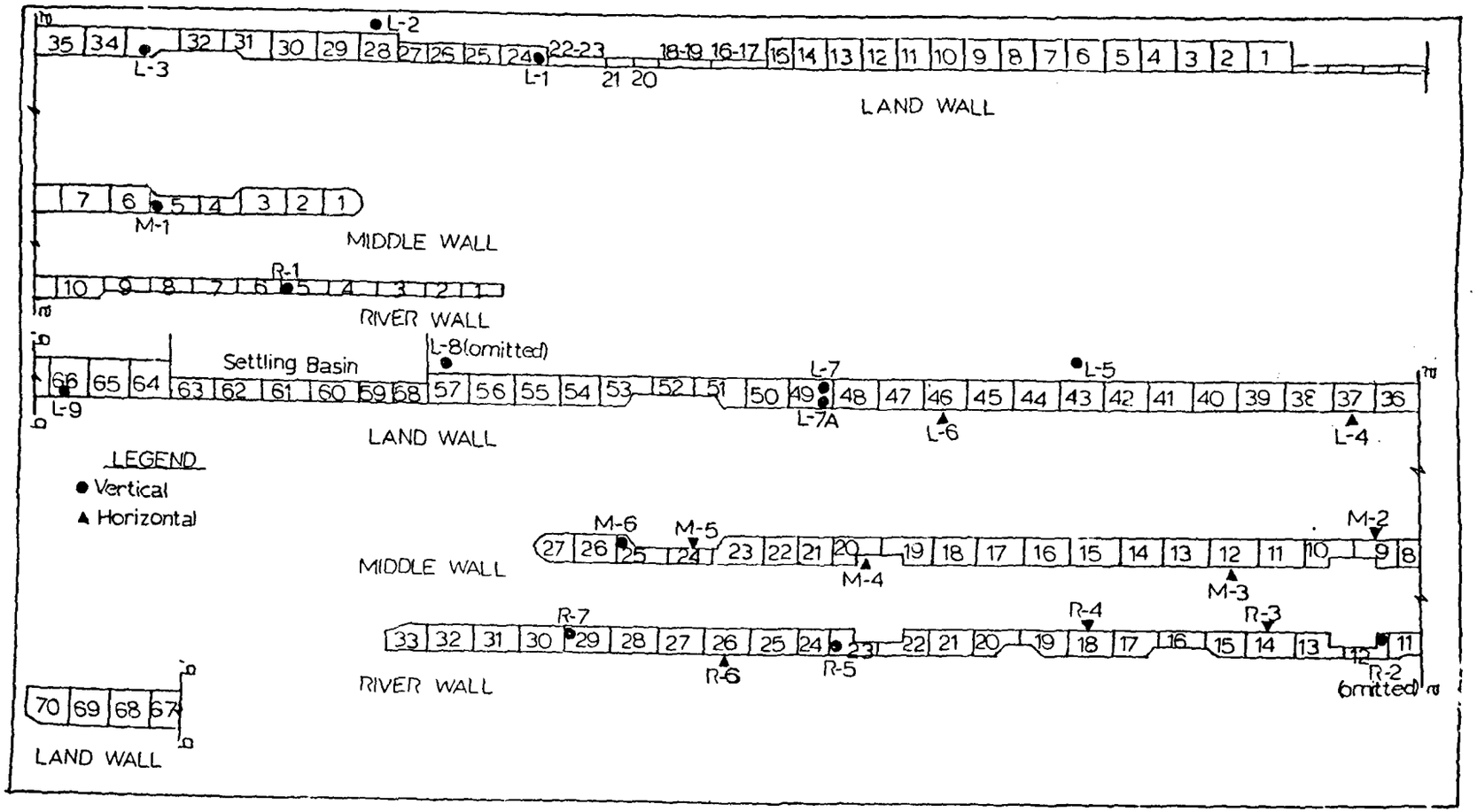
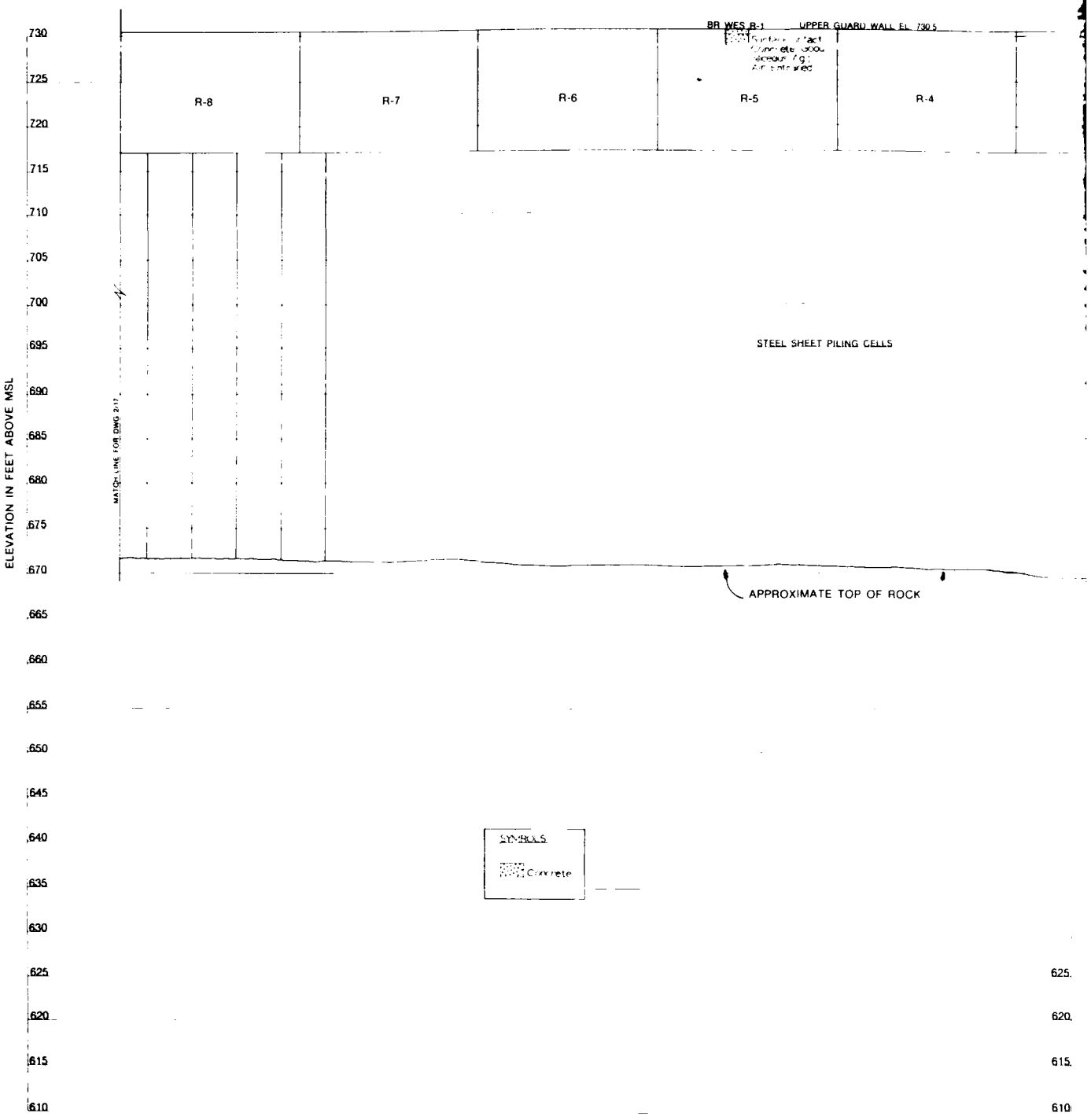


Plate 3



UPPER GUARD WALL

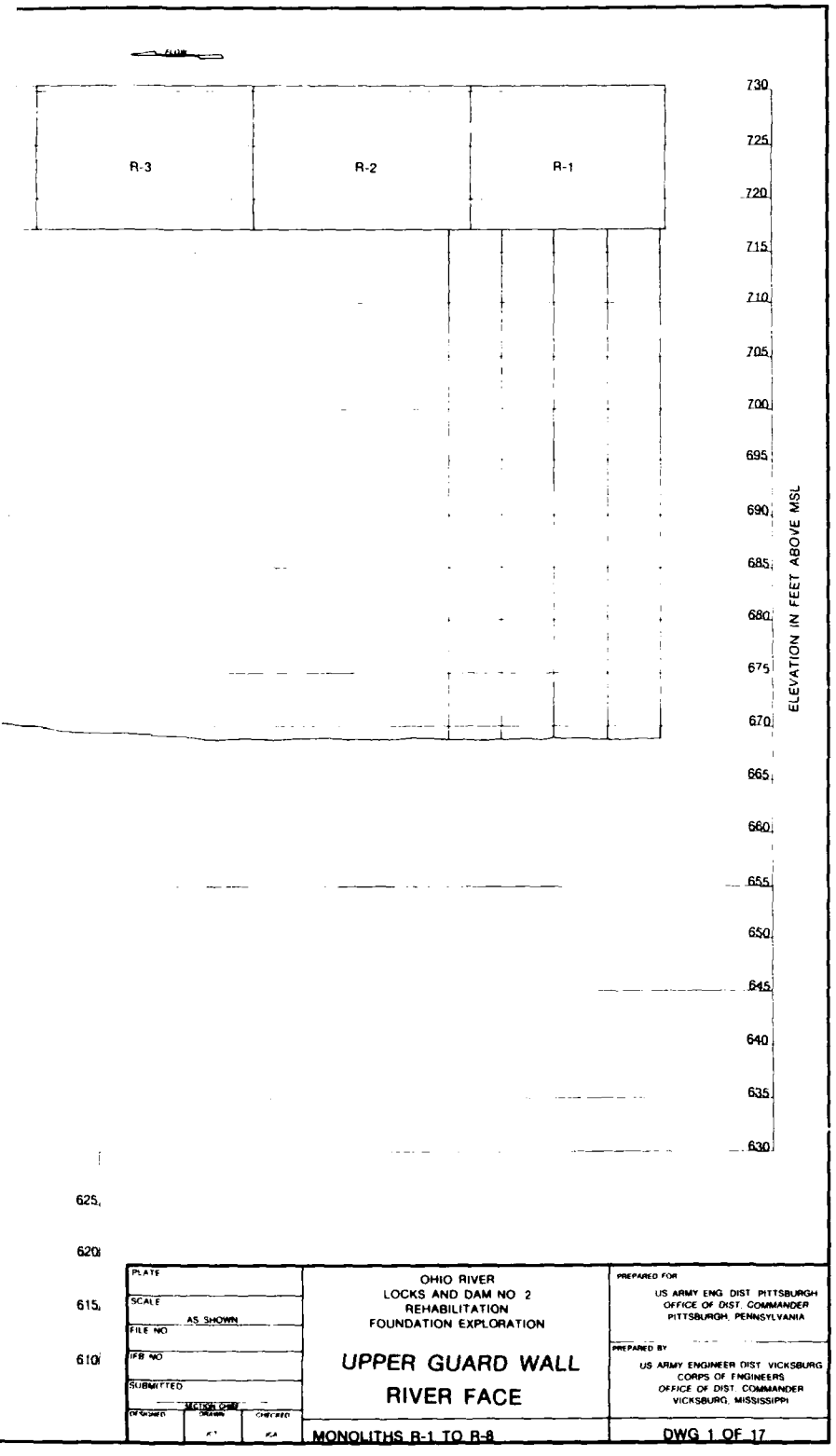
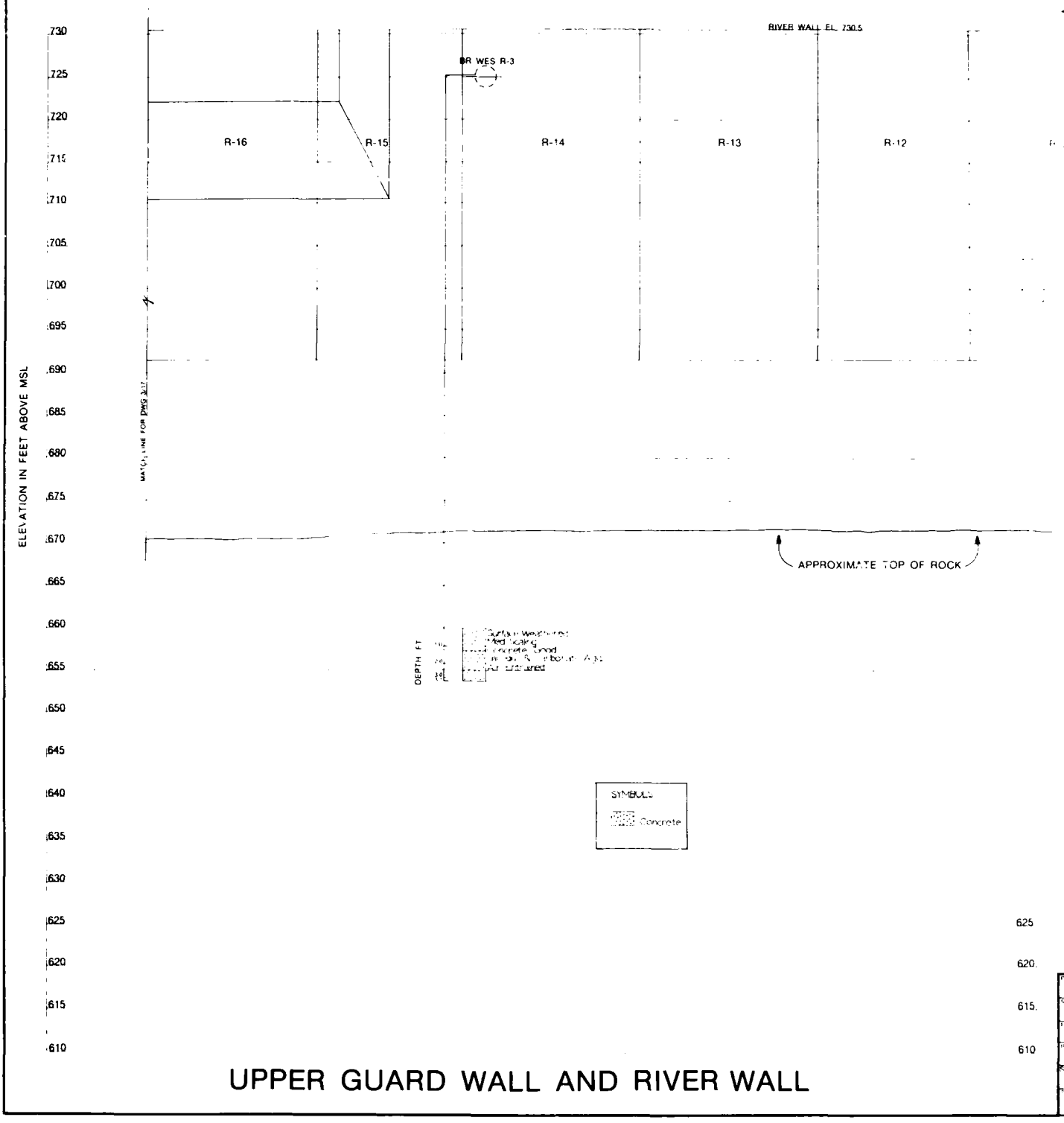


PLATE	OHIO RIVER LOCKS AND DAM NO 2 REHABILITATION FOUNDATION EXPLORATION	PREPARED FOR US ARMY ENG DIST PITTSBURGH OFFICE OF DIST COMMANDER PITTSBURGH, PENNSYLVANIA
SCALE AS SHOWN FILE NO IFB NO SUBMITTED DESIGNED DRAWN CHECKED	UPPER GUARD WALL RIVER FACE	PREPARED BY US ARMY ENGINEER DIST VICKSBURG CORPS OF ENGINEERS OFFICE OF DIST COMMANDER VICKSBURG, MISSISSIPPI
	MONOLITHS R-1 TO R-8	DWG 1 OF 17

PLATE 4



UPPER GUARD WALL AND RIVER WALL

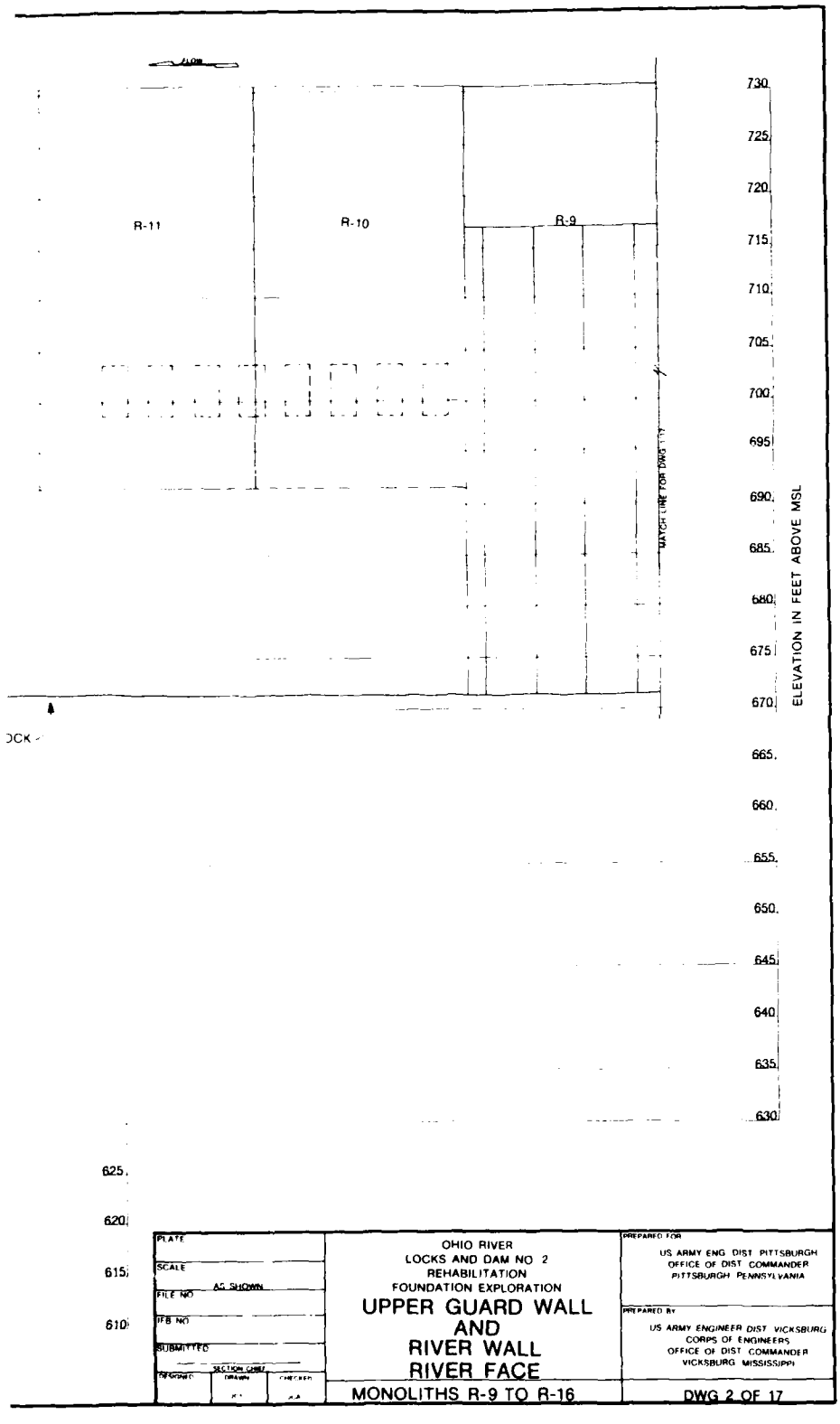
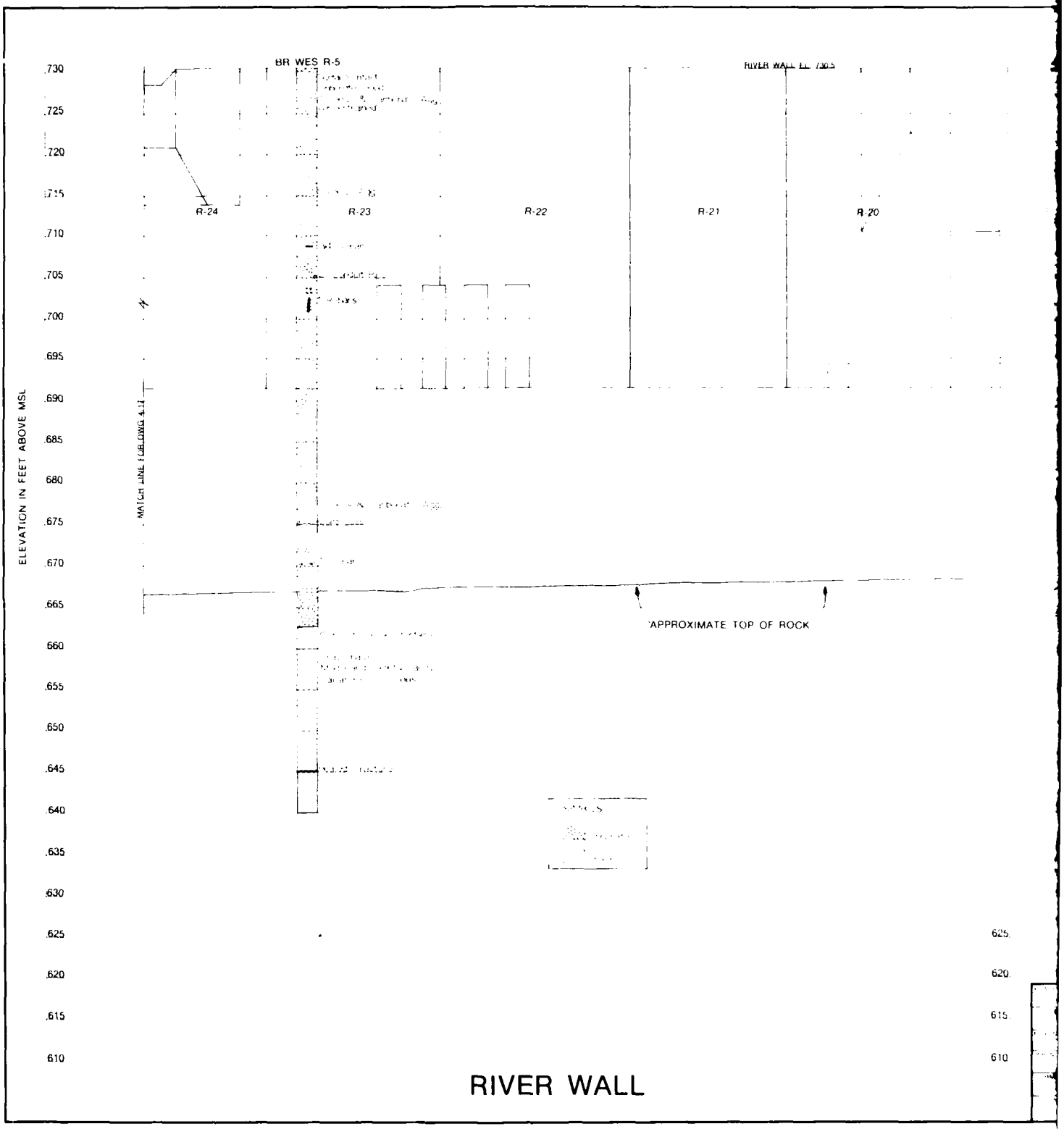


PLATE	OHIO RIVER LOCKS AND DAM NO 2 REHABILITATION FOUNDATION EXPLORATION UPPER GUARD WALL AND RIVER WALL RIVER FACE	PREPARED FOR US ARMY ENG DIST PITTSBURGH OFFICE OF DIST COMMANDER PITTSBURGH PENNSYLVANIA
SCALE AS SHOWN		
FILE NO		PREPARED BY US ARMY ENGINEER DIST VICKSBURG CORPS OF ENGINEERS OFFICE OF DIST COMMANDER VICKSBURG MISSISSIPPI
IFB NO		
SUBMITTED		
SECTION CHIEF DESIGNED / DRAWN / CHECKED	MONOLITHS R-9 TO R-16	DWG 2 OF 17

PLATE 5


BR WES R-5
RIVER WALL EL. 730.5
R-24
R-23
R-22
R-21
R-20
ELEVATION IN FEET ABOVE MSL
730
725
720
715
710
705
700
695
690
685
680
675
670
665
660
655
650
645
640
635
630
625
620
615
610
MATCH LINE FOR DWG 4.11
APPROXIMATE TOP OF ROCK

RIVER WALL

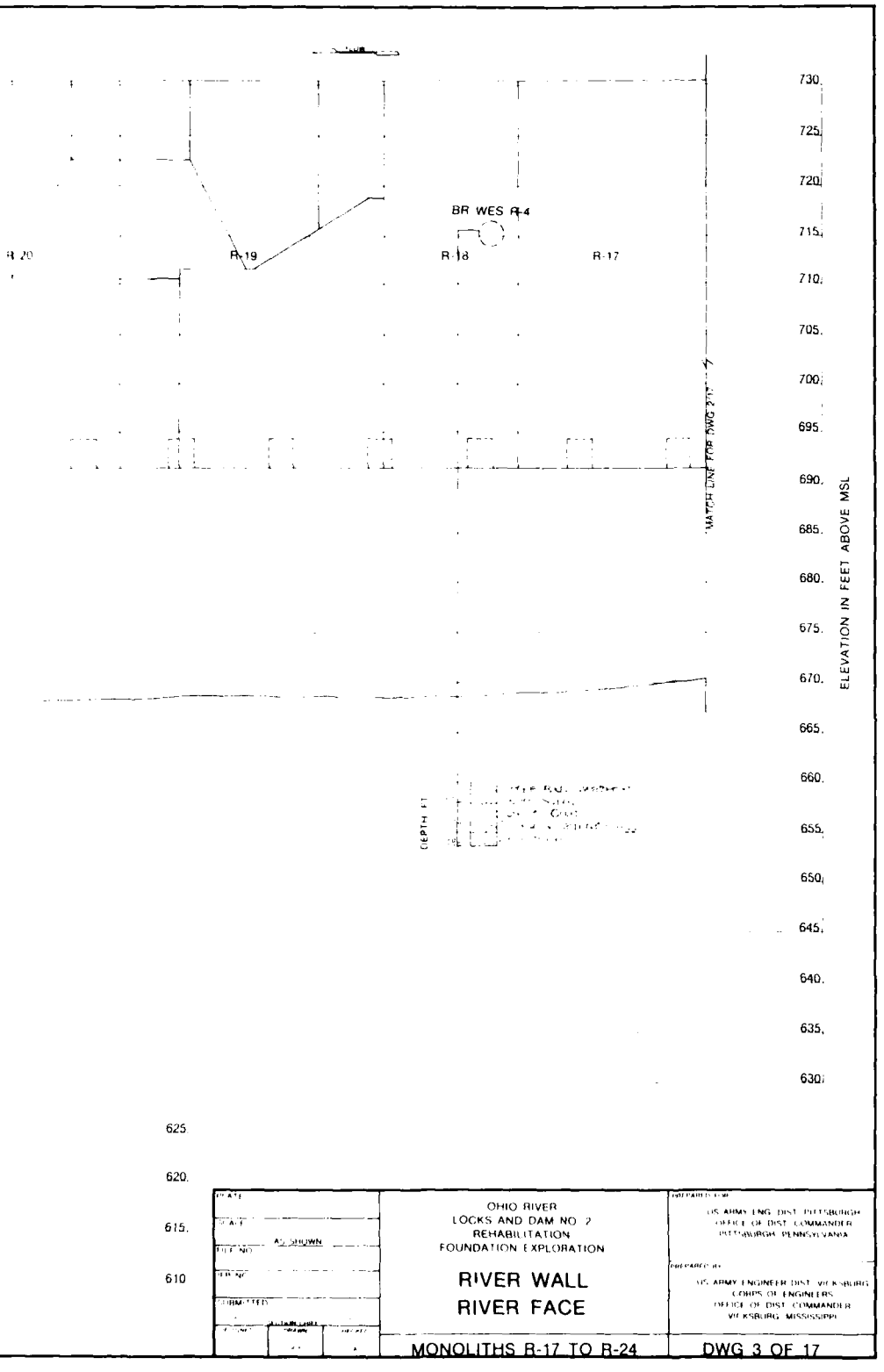
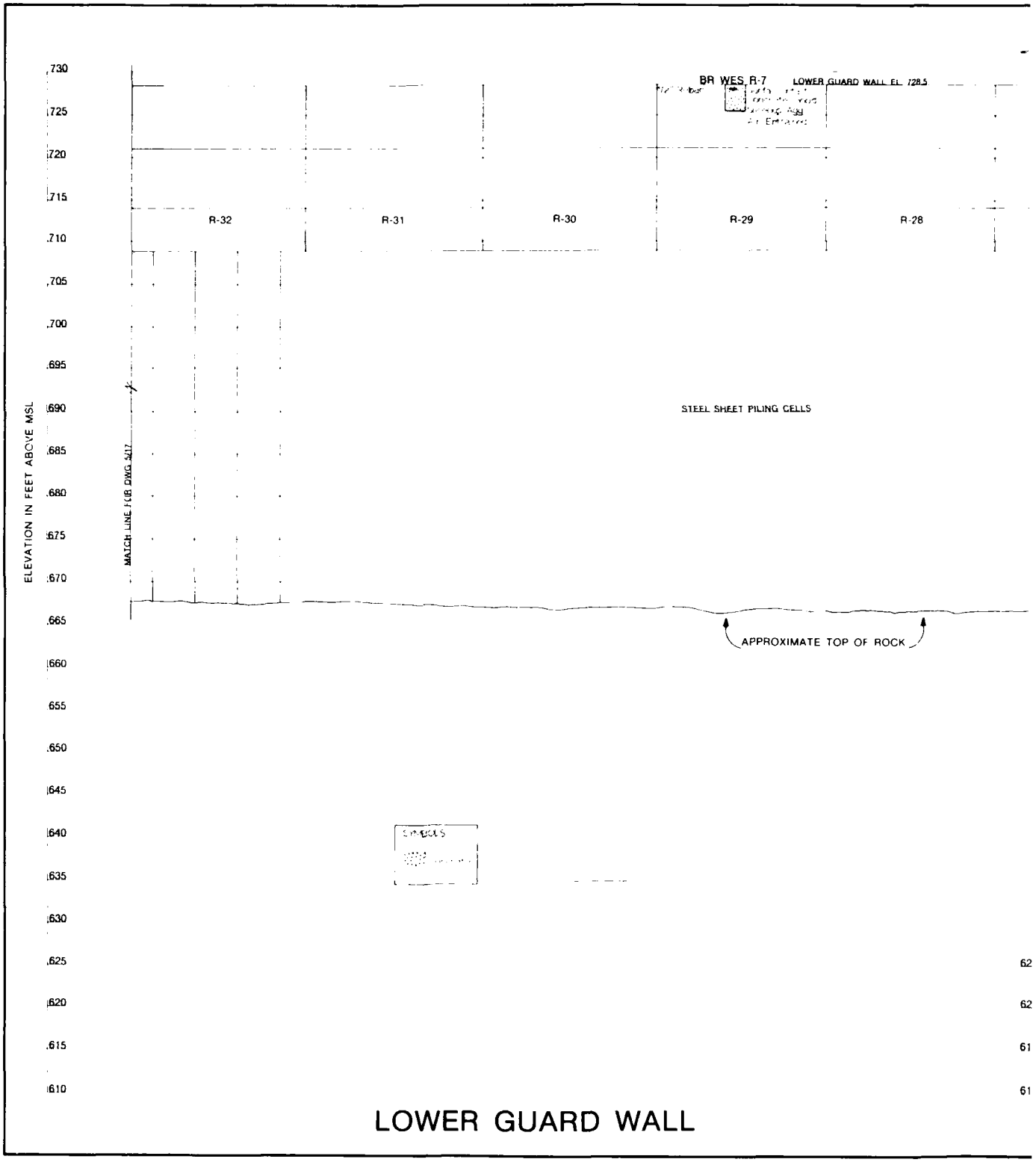

R-20
R-19
R-18
R-17
BR WES R-4
MATCH LINE FOR SWG 2 OF 17
730.
725.
720.
715.
710.
705.
700.
695.
690.
685.
680.
675.
670.
665.
660.
655.
650.
645.
640.
635.
630.
625.
620.
615.
610.
ELEVATION IN FEET ABOVE MSL
DEPTH FT
AS SHOWN
OHIO RIVER
LOCKS AND DAM NO. 2
REHABILITATION
FOUNDATION EXPLORATION
RIVER WALL
RIVER FACE
US ARMY ENG DIST, PITTSBURGH
OFFICE OF DIST. COMMANDER
PITTSBURGH, PENNSYLVANIA
US ARMY ENGINEER DIST, VICKSBURG
CORPS OF ENGINEERS
OFFICE OF DIST. COMMANDER
VICKSBURG, MISSISSIPPI
MONOLITHS R-17 TO R-24
DWG 3 OF 17

PLATE 6



LOWER GUARD WALL

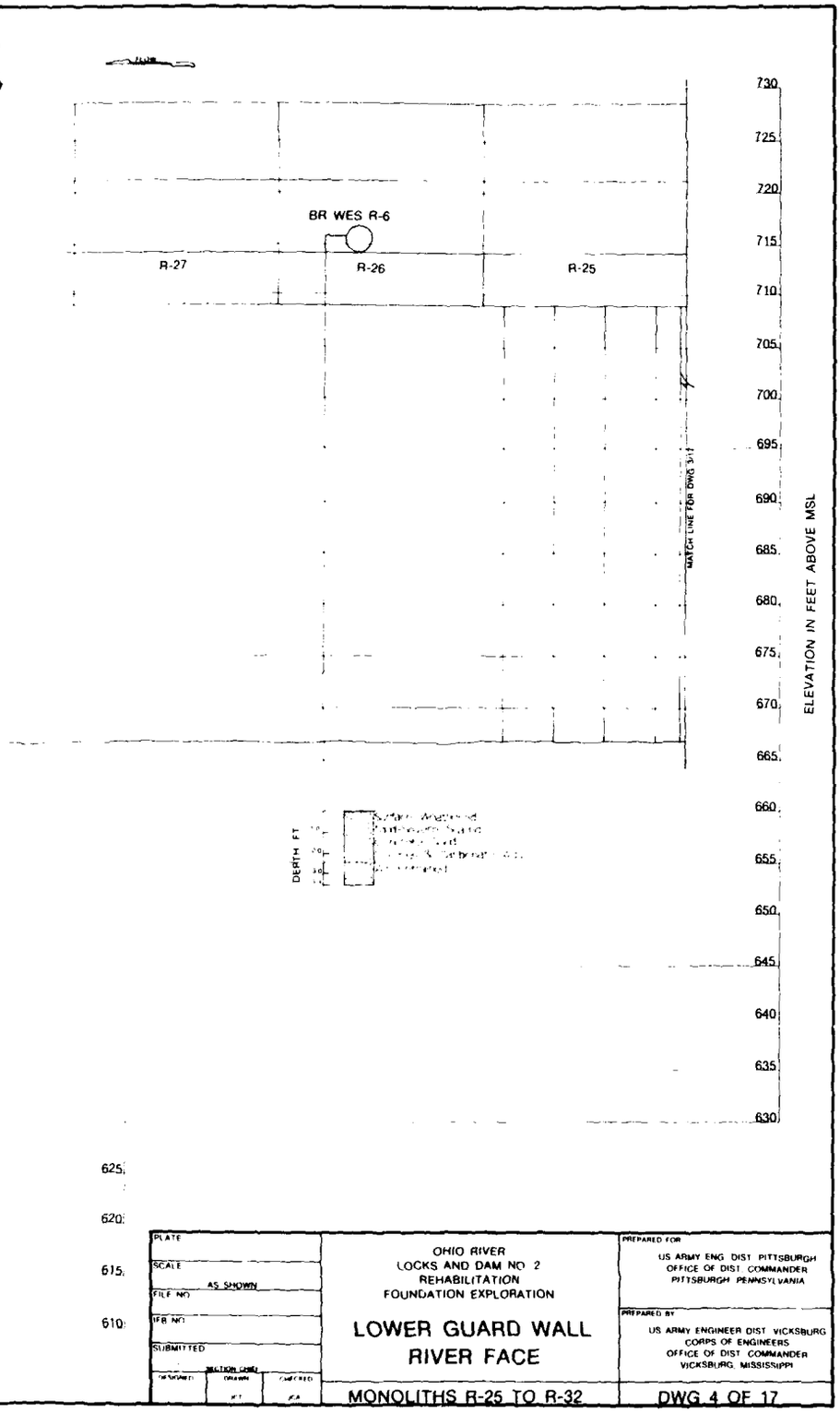
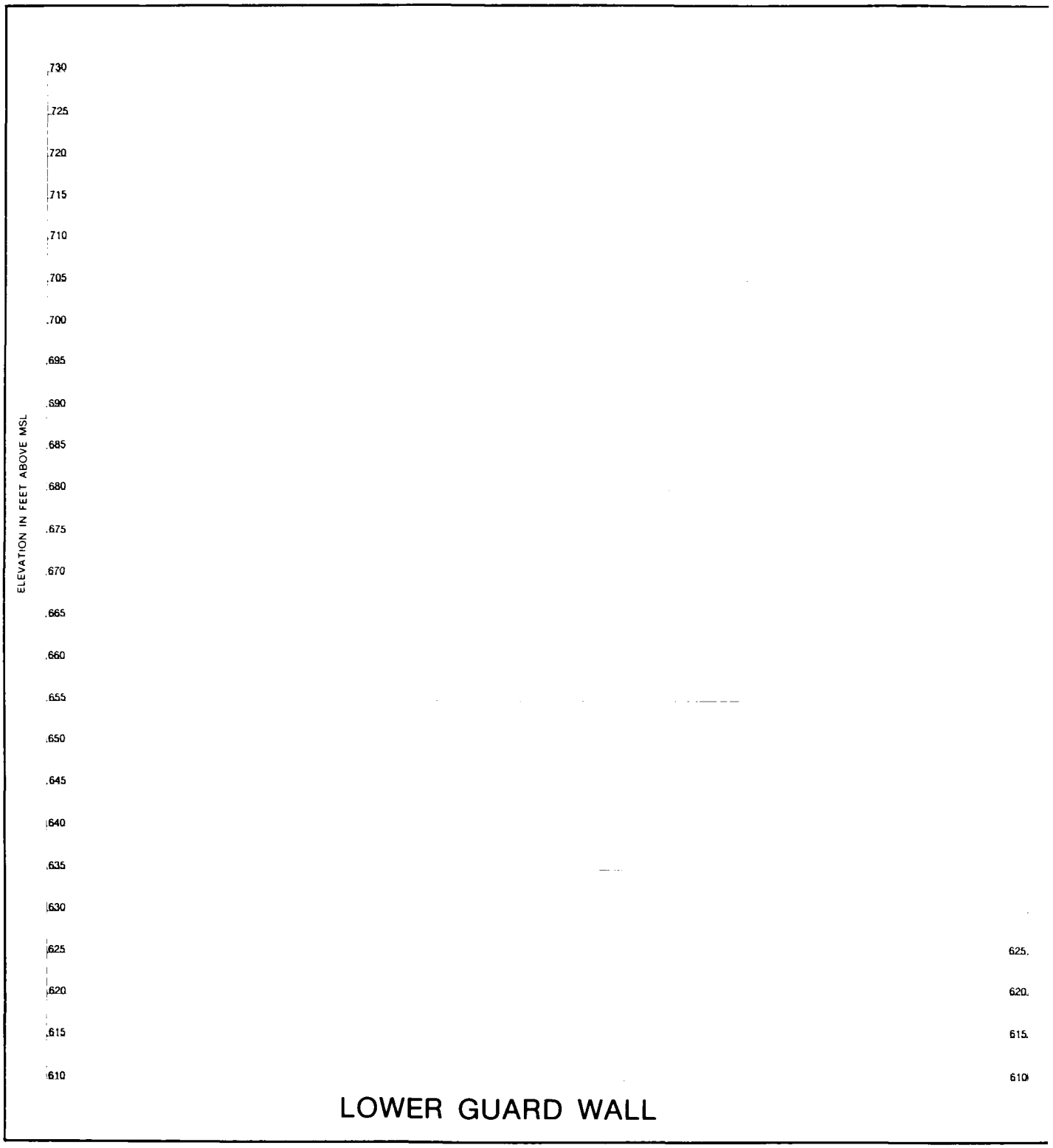
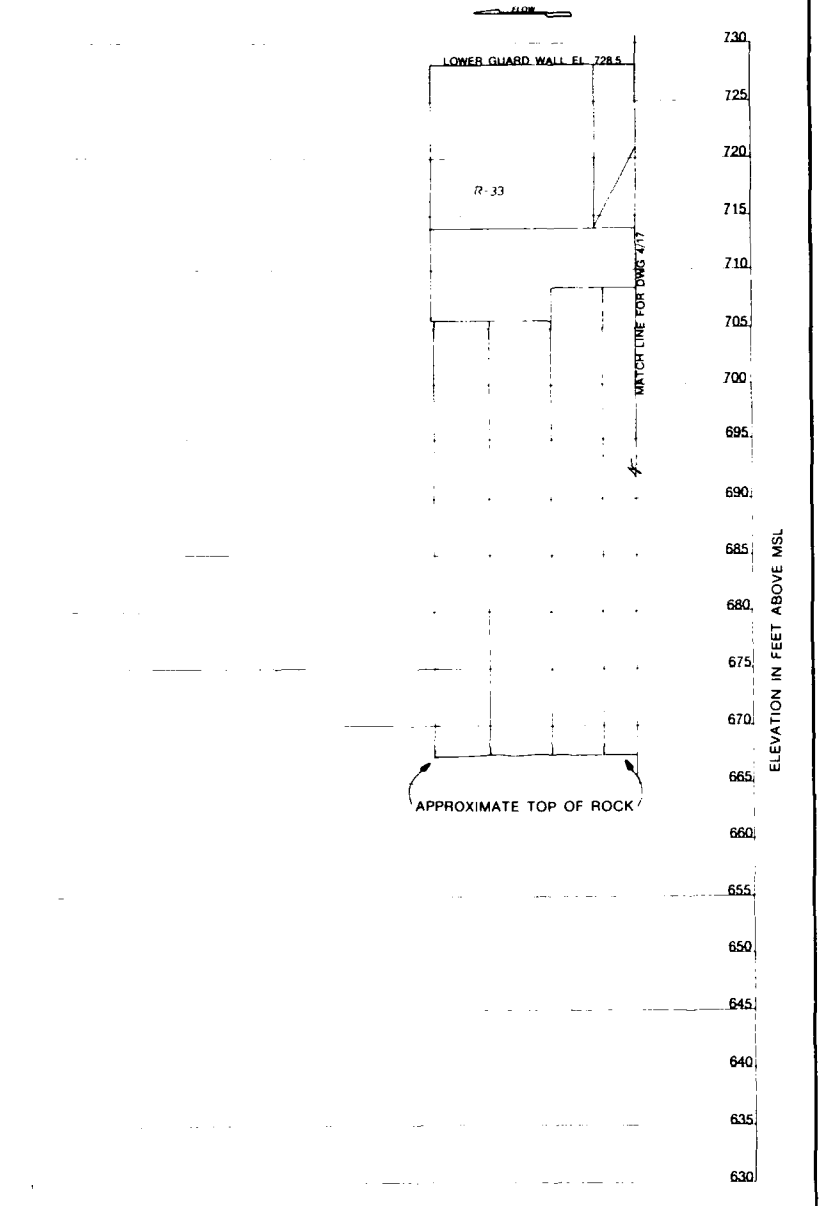

BR WES R-6
R-27
R-26
R-25
730
725
720
715
710
705
700
695
690
685
680
675
670
665
660
655
650
645
640
635
630
625
620
615
610
MATCH LINE FOR DWG 3-17
ELEVATION IN FEET ABOVE MSL
DEPTH FT
PLATE
SCALE
AS SHOWN
FILE NO
IFB NO
SUBMITTED
OHIO RIVER
LOCKS AND DAM NO 2
REHABILITATION
FOUNDATION EXPLORATION
LOWER GUARD WALL
RIVER FACE
MONOLITHS R-25 TO R-32
PREPARED FOR
US ARMY ENG DIST PITTSBURGH
OFFICE OF DIST COMMANDER
PITTSBURGH PENNSYLVANIA
PREPARED BY
US ARMY ENGINEER DIST VICKSBURG
CORPS OF ENGINEERS
OFFICE OF DIST COMMANDER
VICKSBURG MISSISSIPPI
DWG 4 OF 17

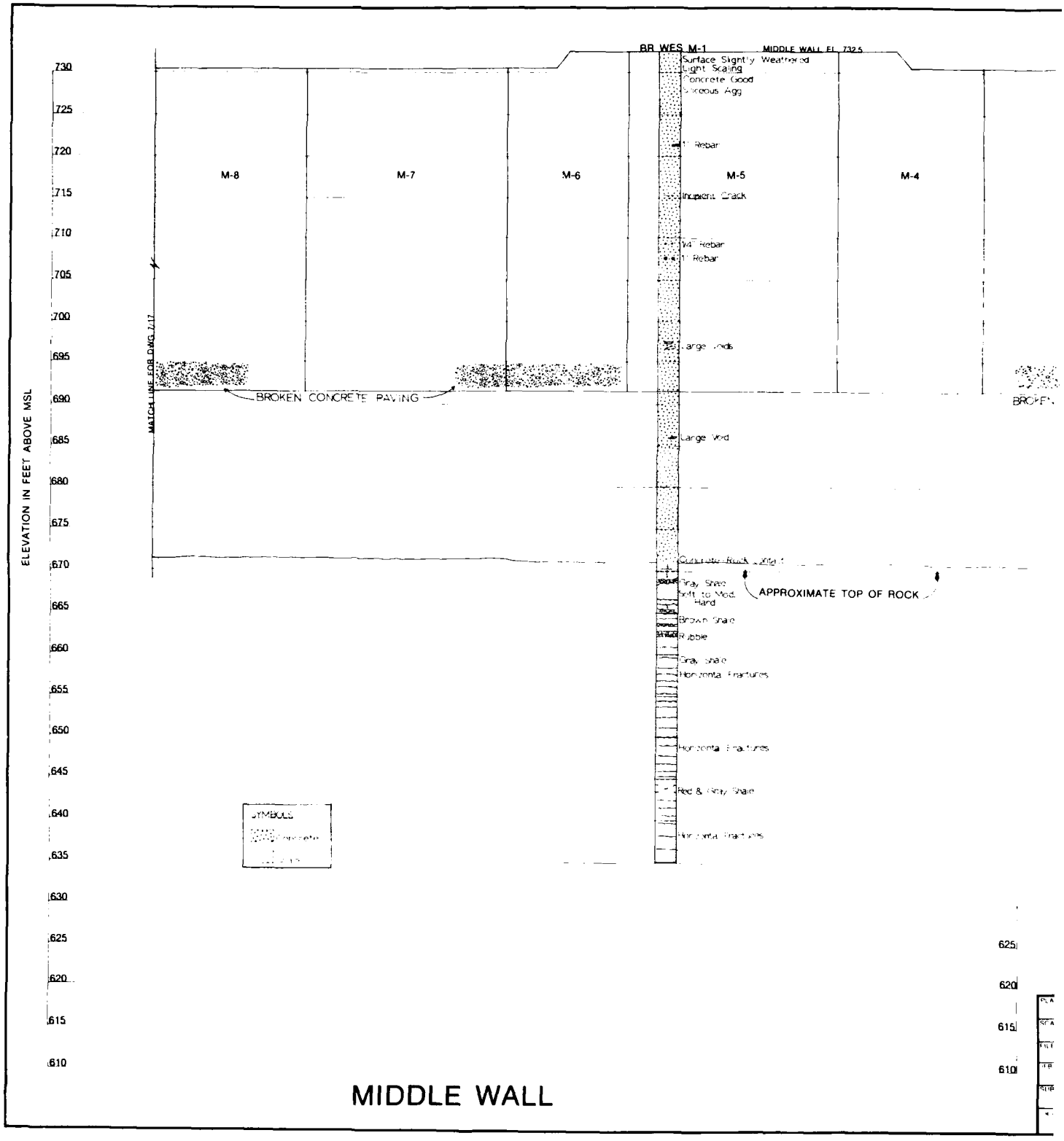
PLATE 7


730
725
720
715
710
705
700
695
690
685
680
675
670
665
660
655
650
645
640
635
630
625
620
615
610
ELEVATION IN FEET ABOVE MSL
625.
620.
615.
610
LOWER GUARD WALL



DRAFT SCALE: AS SHOWN FILE NO. IFB NO. SUBMITTED SECTION CHIEF DESIGNED / DRAWN / CHECKED	OHIO RIVER LOCKS AND DAM NO 2 REHABILITATION FOUNDATION EXPLORATION **LOWER GUARD WALL** **RIVER FACE**	PREPARED FOR: US ARMY ENG DIST PITTSBURGH OFFICE OF DIST COMMANDER PITTSBURGH PENNSYLVANIA PREPARED BY: US ARMY ENGINEER DIST VICKSBURG CORPS OF ENGINEERS OFFICE OF DIST COMMANDER VICKSBURG, MISSISSIPPI
MONOLITH R-33		DWG 5 OF 17

PLATE 8


BR WES M-1
MIDDLE WALL EL 732.5
Surface Slightly Weathered
Light Scaling
Concrete Good
Siliceous Agg
1" Rebar
M-8
M-7
M-6
M-5
M-4
Incipient Crack
1/4" Rebar
1" Rebar
Large Voids
MATCH LINE FOR DWG. 7.17
BROKEN CONCRETE PAVING
Large Void
Gray Shale
Soft to Med. Hard
APPROXIMATE TOP OF ROCK
Brown Shale
Rubble
Gray Shale
Horizontal Fractures
Horizontal Fractures
Red & Gray Shale
Horizontal Fractures
SYMBOLS
ELEVATION IN FEET ABOVE MSL
730
725
720
715
710
705
700
695
690
685
680
675
670
665
660
655
650
645
640
635
630
625
620
615
610

MIDDLE WALL

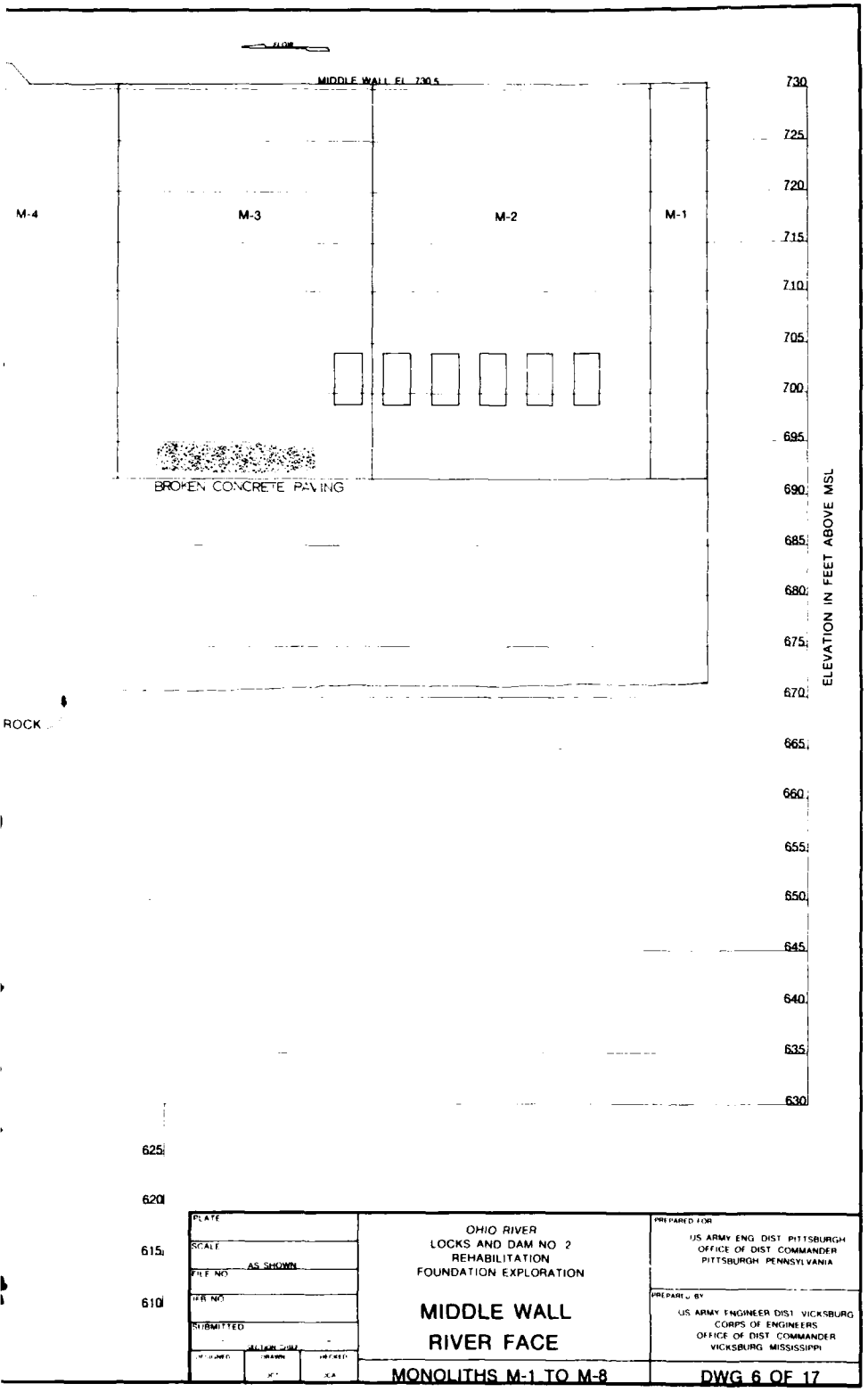
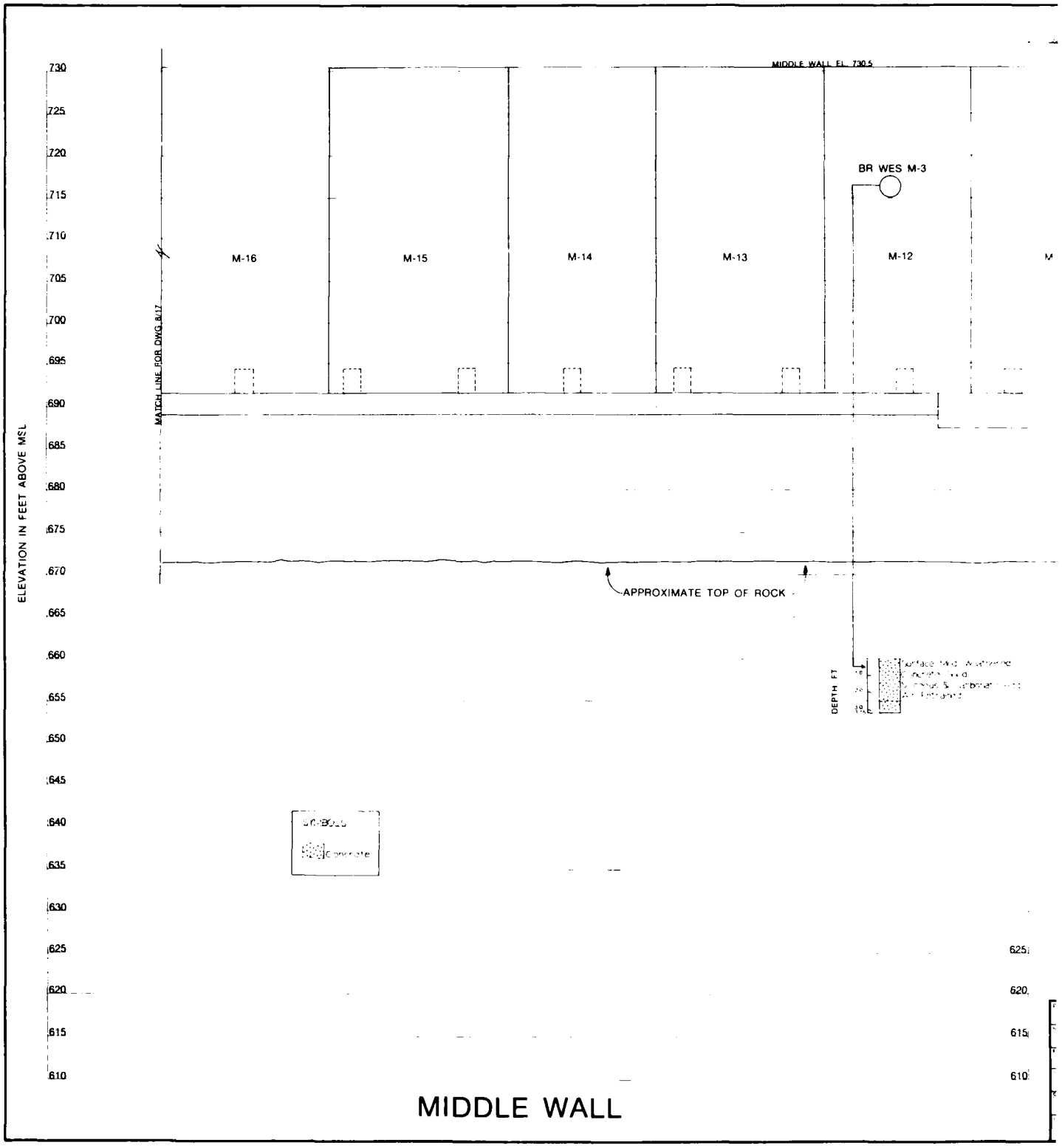


PLATE SCALE AS SHOWN FILE NO IER NO SUBMITTED	OHIO RIVER LOCKS AND DAM NO 2 REHABILITATION FOUNDATION EXPLORATION **MIDDLE WALL** **RIVER FACE**	PREPARED FOR US ARMY ENG DIST PITTSBURGH OFFICE OF DIST COMMANDER PITTSBURGH PENNSYLVANIA PREPARED BY US ARMY ENGINEER DIST VICKSBURG CORPS OF ENGINEERS OFFICE OF DIST COMMANDER VICKSBURG MISSISSIPPI
DESIGNED / DRAWN / CHECKED JC / JCA	MONOLITHS M-1 TO M-8	DWG 6 OF 17

PLATE 9


730
725
720
715
710
705
700
695
690
685
680
675
670
665
660
655
650
645
640
635
630
625
620
615
610
ELEVATION IN FEET ABOVE MSL
MIDDLE WALL EL. 730.5
BR WES M-3
M-16
M-15
M-14
M-13
M-12
MATCH LINE FOR DWG. 8417
APPROXIMATE TOP OF ROCK
DEPTH FT
Concrete

MIDDLE WALL

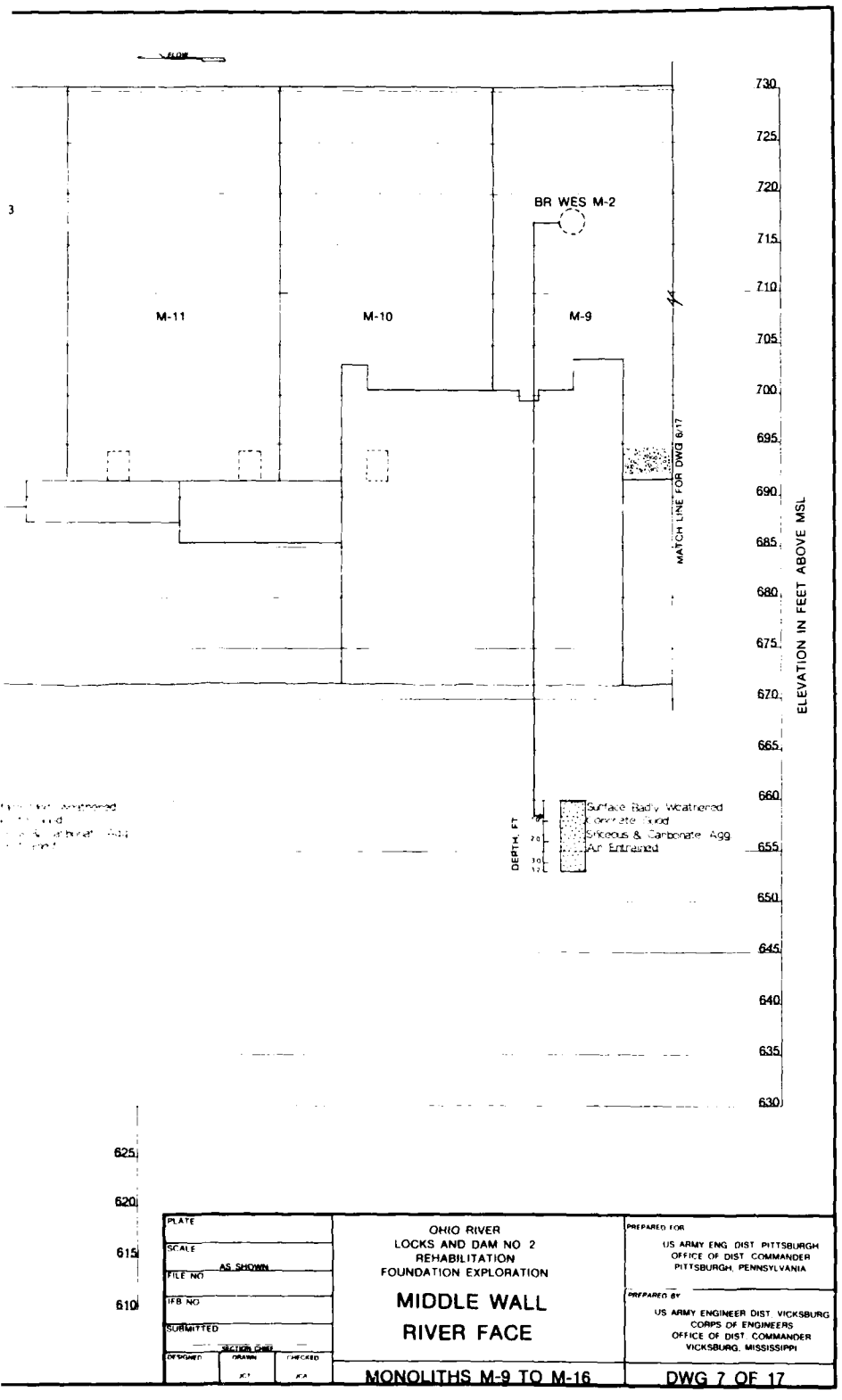
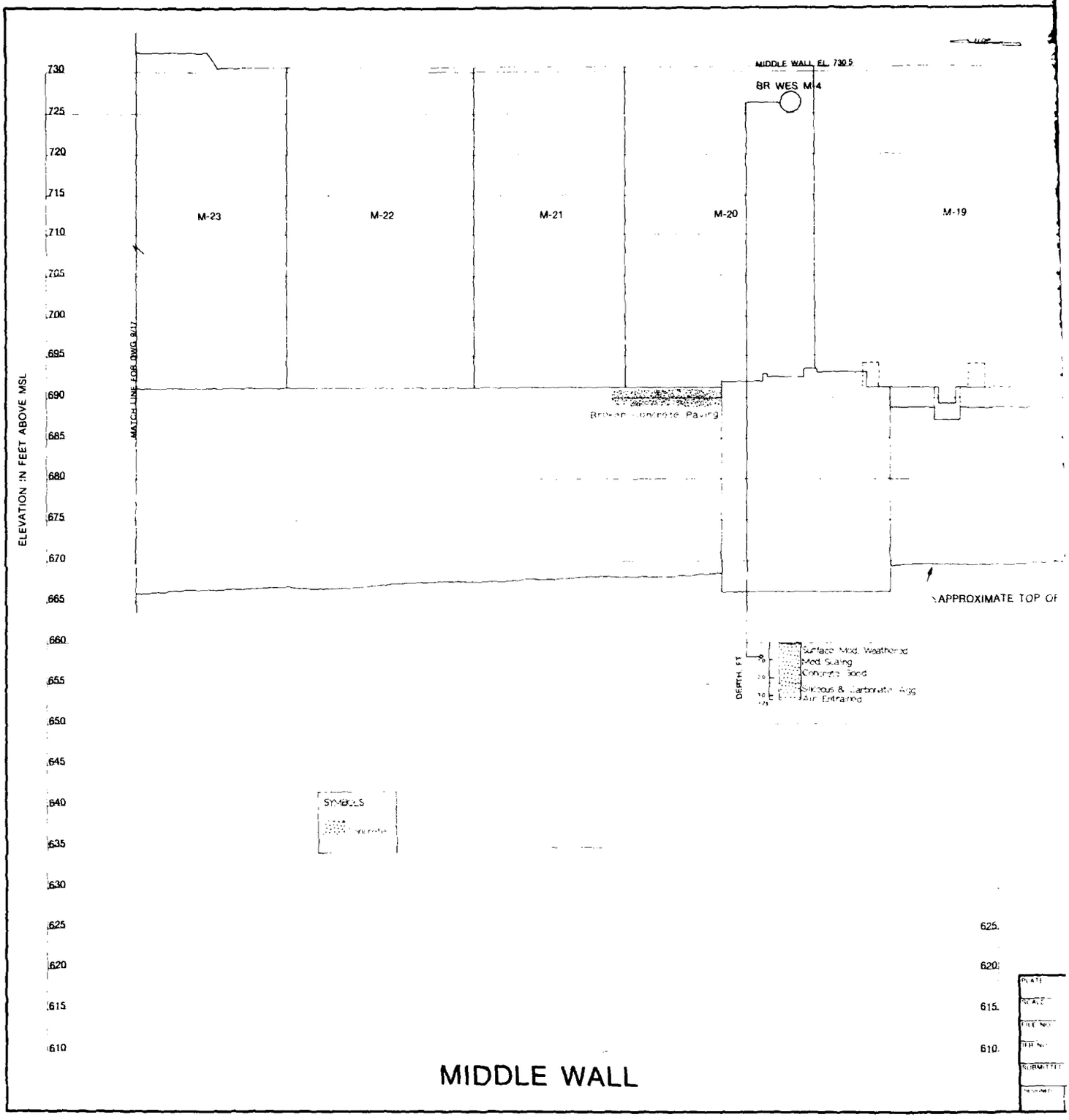
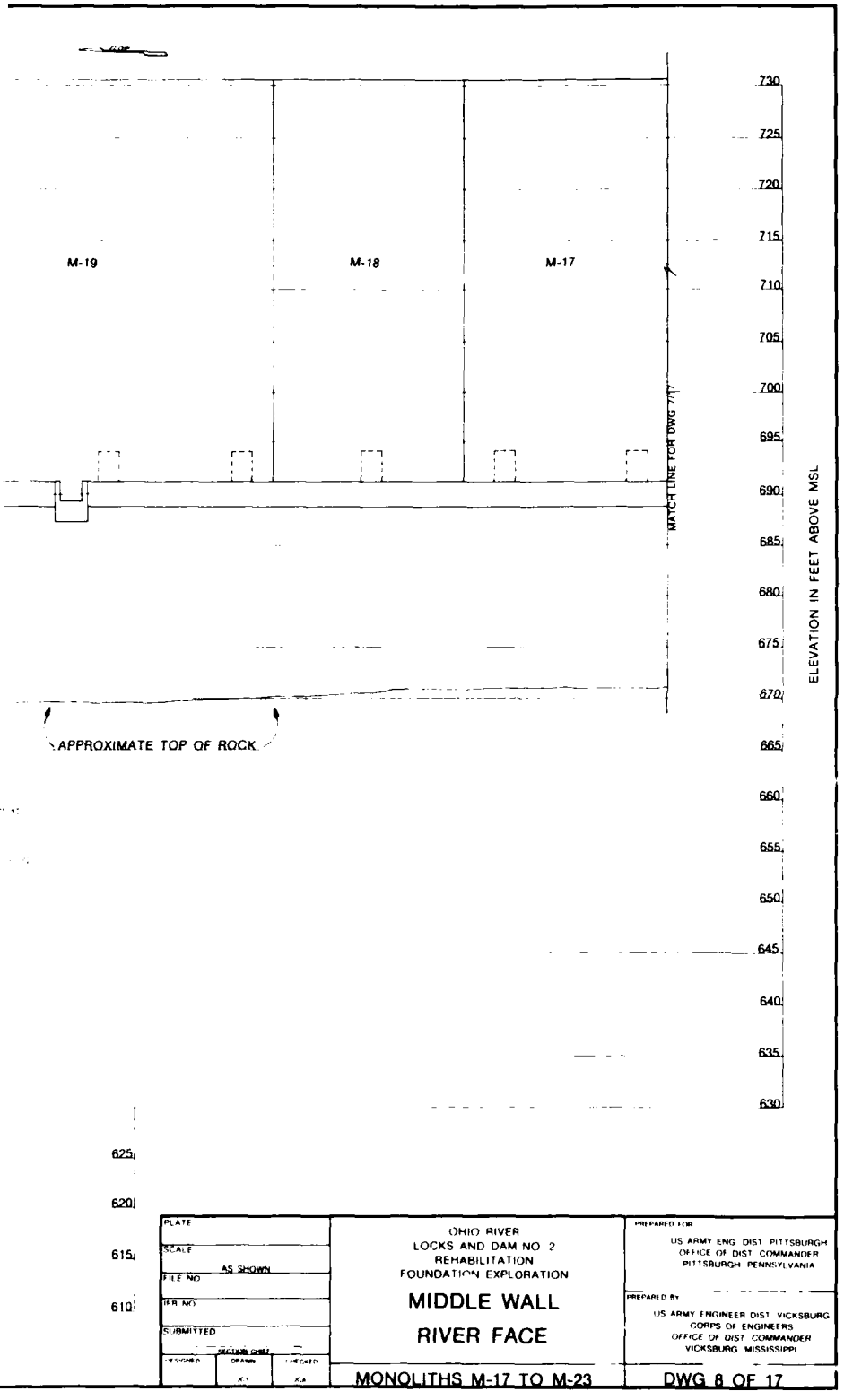

FLOW
BR WES M-2
M-11
M-10
M-9
MATCH LINE FOR DWG 6/17
730
725
720
715
710
705
700
695
690
685
680
675
670
665
660
655
650
645
640
635
630
625
620
615
610
ELEVATION IN FEET ABOVE MSL
DEPTH, FT
Surface Badly Weathered
Concrete Void
Siliceous & Carbonate Agg
Air Entrained
PLATE
SCALE
AS SHOWN
FILE NO
IFB NO
SUBMITTED
SECTION CHIEF
DESIGNED
DRAWN
CHECKED
OHIO RIVER
LOCKS AND DAM NO 2
REHABILITATION
FOUNDATION EXPLORATION
MIDDLE WALL
RIVER FACE
MONOLITHS M-9 TO M-16
PREPARED FOR
US ARMY ENG DIST PITTSBURGH
OFFICE OF DIST COMMANDER
PITTSBURGH, PENNSYLVANIA
PREPARED BY
US ARMY ENGINEER DIST VICKSBURG
CORPS OF ENGINEERS
OFFICE OF DIST COMMANDER
VICKSBURG, MISSISSIPPI
DWG 7 OF 17

PLATE 10


730
725
720
715
710
705
700
695
690
685
680
675
670
665
660
655
650
645
640
635
630
625
620
615
610
ELEVATION IN FEET ABOVE MSL
MATCH LINE FOR DWG 9417
M-23
M-22
M-21
M-20
M-19
MIDDLE WALL EL. 730.5
8R WES M-4
Broken Concrete Paving
APPROXIMATE TOP OF
DEPTH, FT
Surface Mod. Weathered
Med. Scaling
Concrete Good
Siliceous & Carbonate Agg.
Air Entraining
SYMBOLS
625.
620.
615.
610.
PLATE
SCALE
FILE NO.
SUBMITTED

MIDDLE WALL



PLATE

SCALE AS SHOWN

FILE NO

FER NO

SUBMITTED

SECTION CHIEF

DESIGNED | DRAWN | CHECKED

OHIO RIVER
LOCKS AND DAM NO 2
REHABILITATION
FOUNDATION EXPLORATION

MIDDLE WALL
RIVER FACE

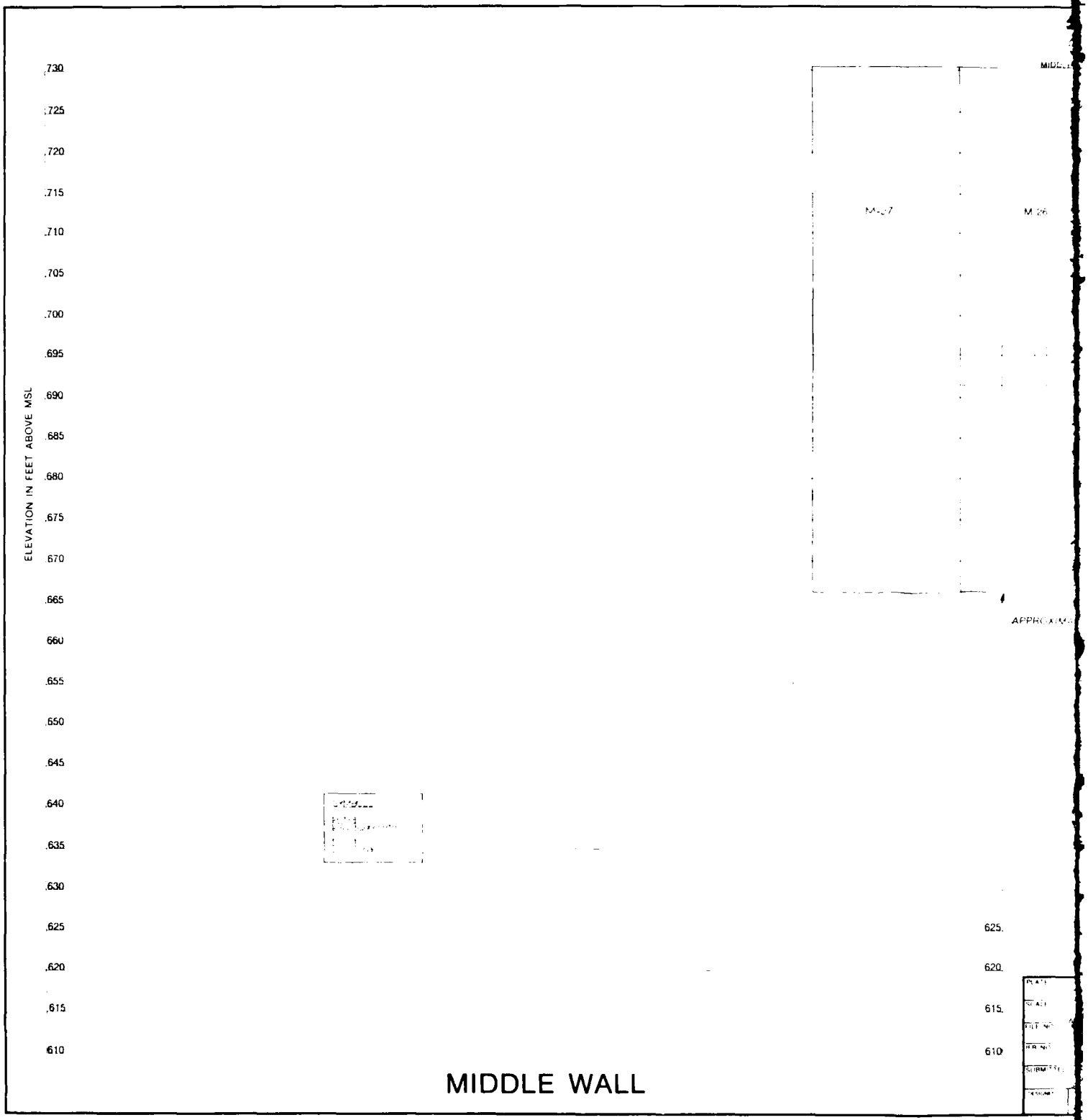
MONOLITHS M-17 TO M-23

PREPARED FOR
US ARMY ENG DIST PITTSBURGH
OFFICE OF DIST COMMANDER
PITTSBURGH PENNSYLVANIA

PREPARED BY
US ARMY ENGINEER DIST VICKSBURG
CORPS OF ENGINEERS
OFFICE OF DIST COMMANDER
VICKSBURG MISSISSIPPI

DWG 8 OF 17

PLATE 11


ELEVATION IN FEET ABOVE MSL
730
725
720
715
710
705
700
695
690
685
680
675
670
665
660
655
650
645
640
635
630
625
620
615
610
625.
620.
615.
610
MIDDLE WALL

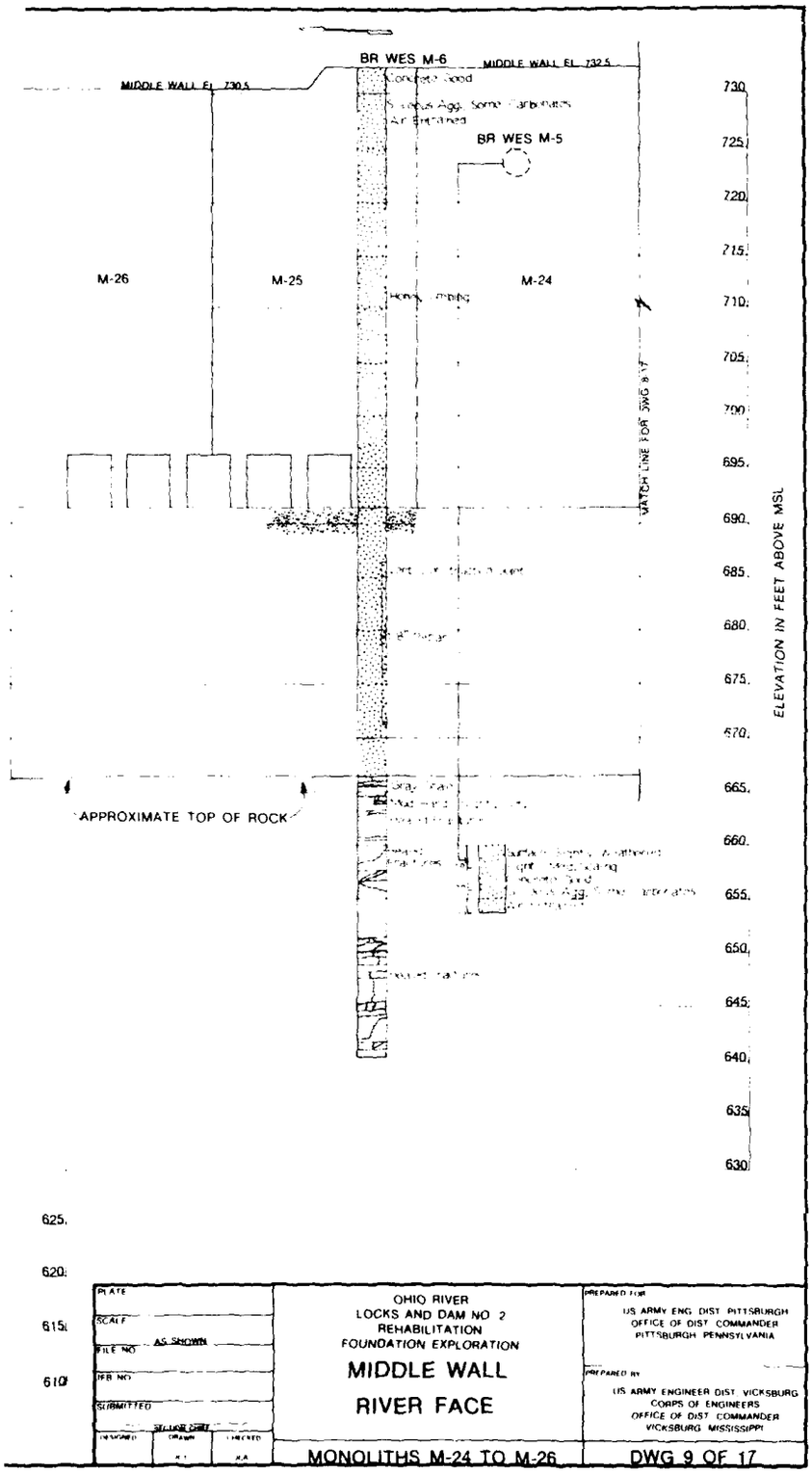
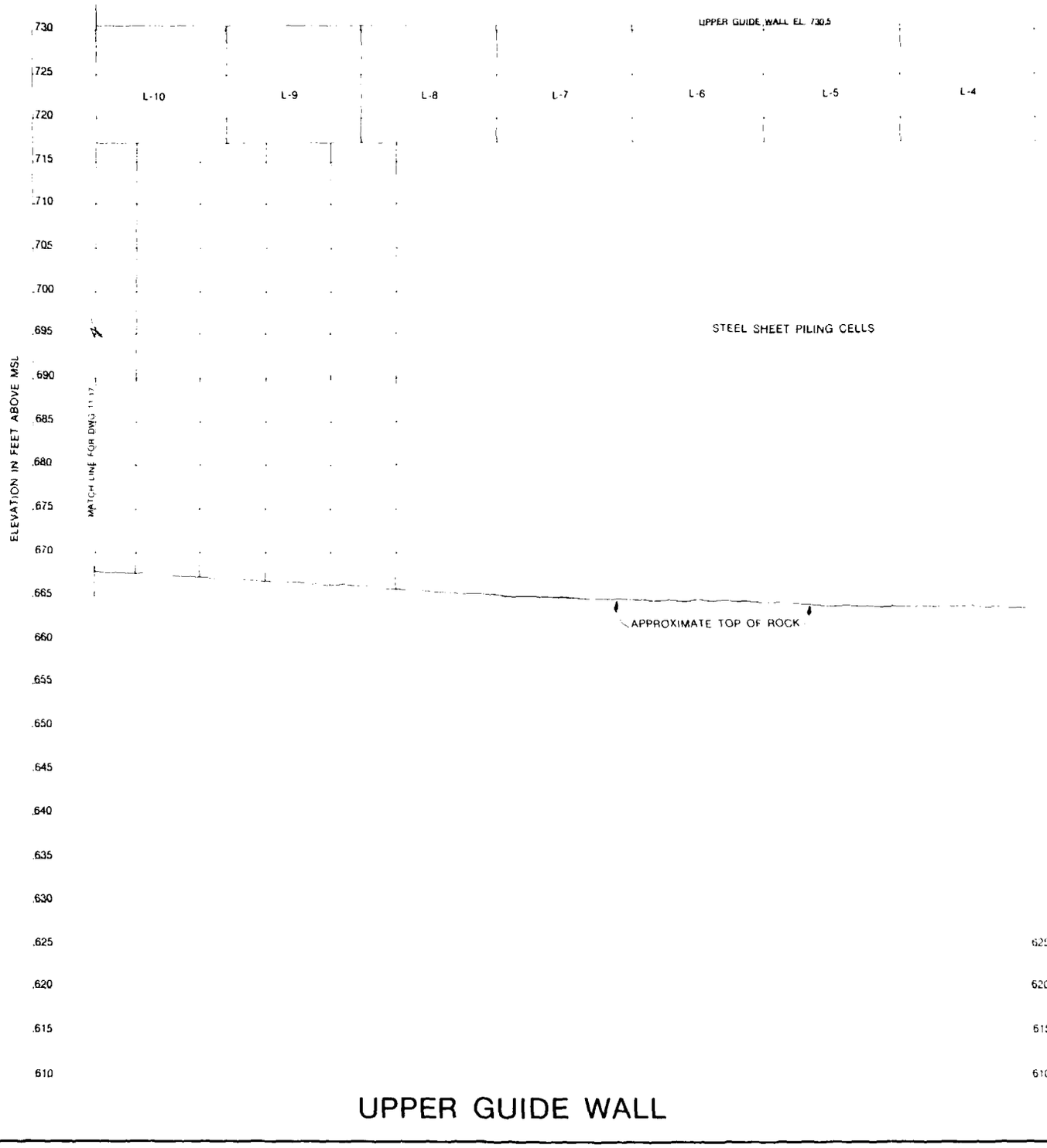

BR WES M-6
MIDDLE WALL EL 730.5
MIDDLE WALL EL 732.5
Concrete Head
BR WES M-5
M-26
M-25
M-24
WATCH LINE FOR SWG 8-17
730.
725.
720.
715.
710.
705.
700.
695.
690.
685.
680.
675.
670.
665.
660.
655.
650.
645.
640.
635.
630.
625.
620.
615.
610.
ELEVATION IN FEET ABOVE MSL
APPROXIMATE TOP OF ROCK
PLATE
SCALE
AS SHOWN
FILE NO.
JOB NO.
SUBMITTED
SIGNATURE SHEET
DRAWN
CHECKED
OHIO RIVER
LOCKS AND DAM NO 2
REHABILITATION
FOUNDATION EXPLORATION
MIDDLE WALL
RIVER FACE
MONOLITHS M-24 TO M-26
PREPARED FOR
US ARMY ENG DIST PITTSBURGH
OFFICE OF DIST COMMANDER
PITTSBURGH PENNSYLVANIA
PREPARED BY
US ARMY ENGINEER DIST VICKSBURG
CORPS OF ENGINEERS
OFFICE OF DIST COMMANDER
VICKSBURG MISSISSIPPI
DWG 9 OF 17

PLATE 12



UPPER GUIDE WALL

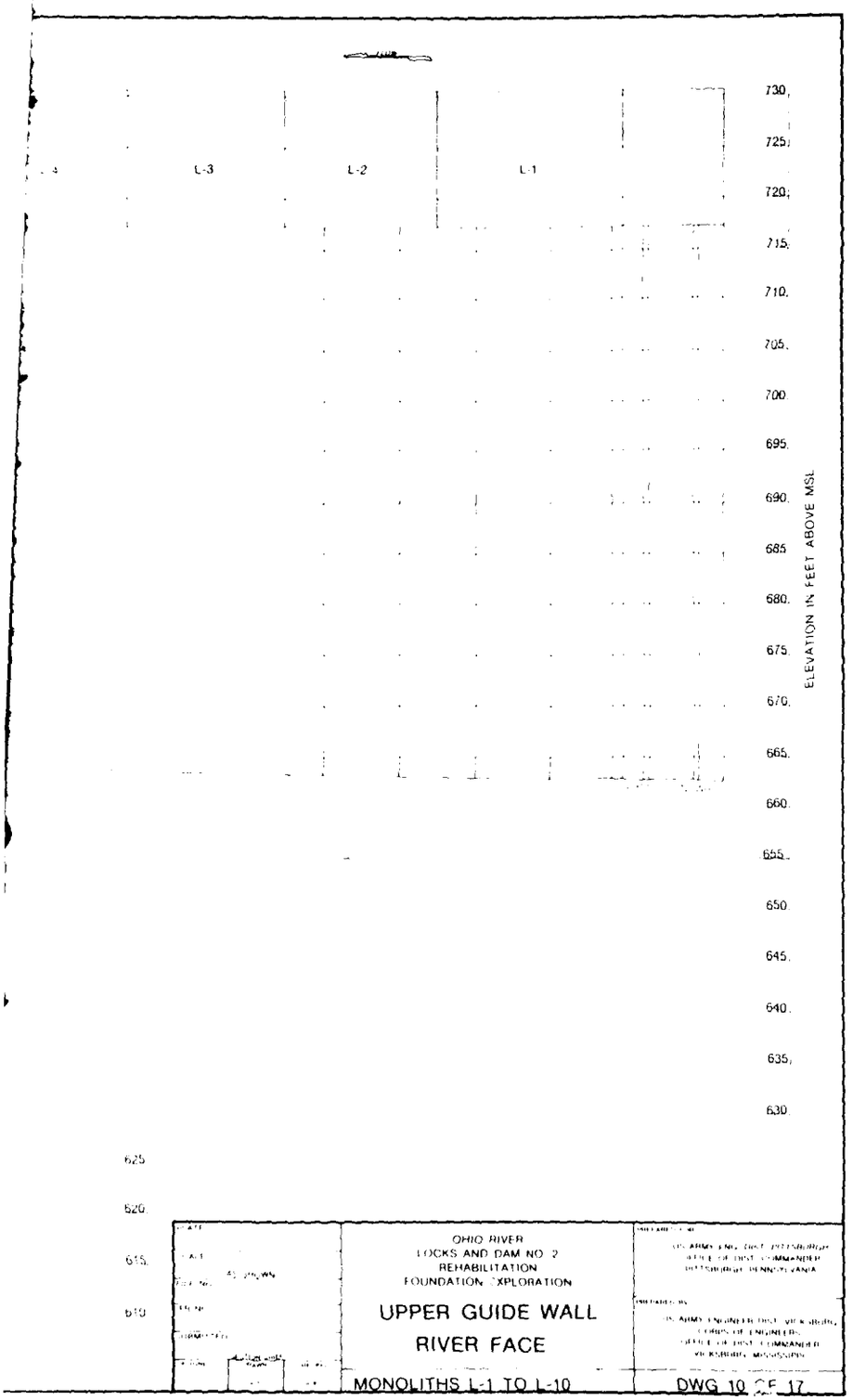
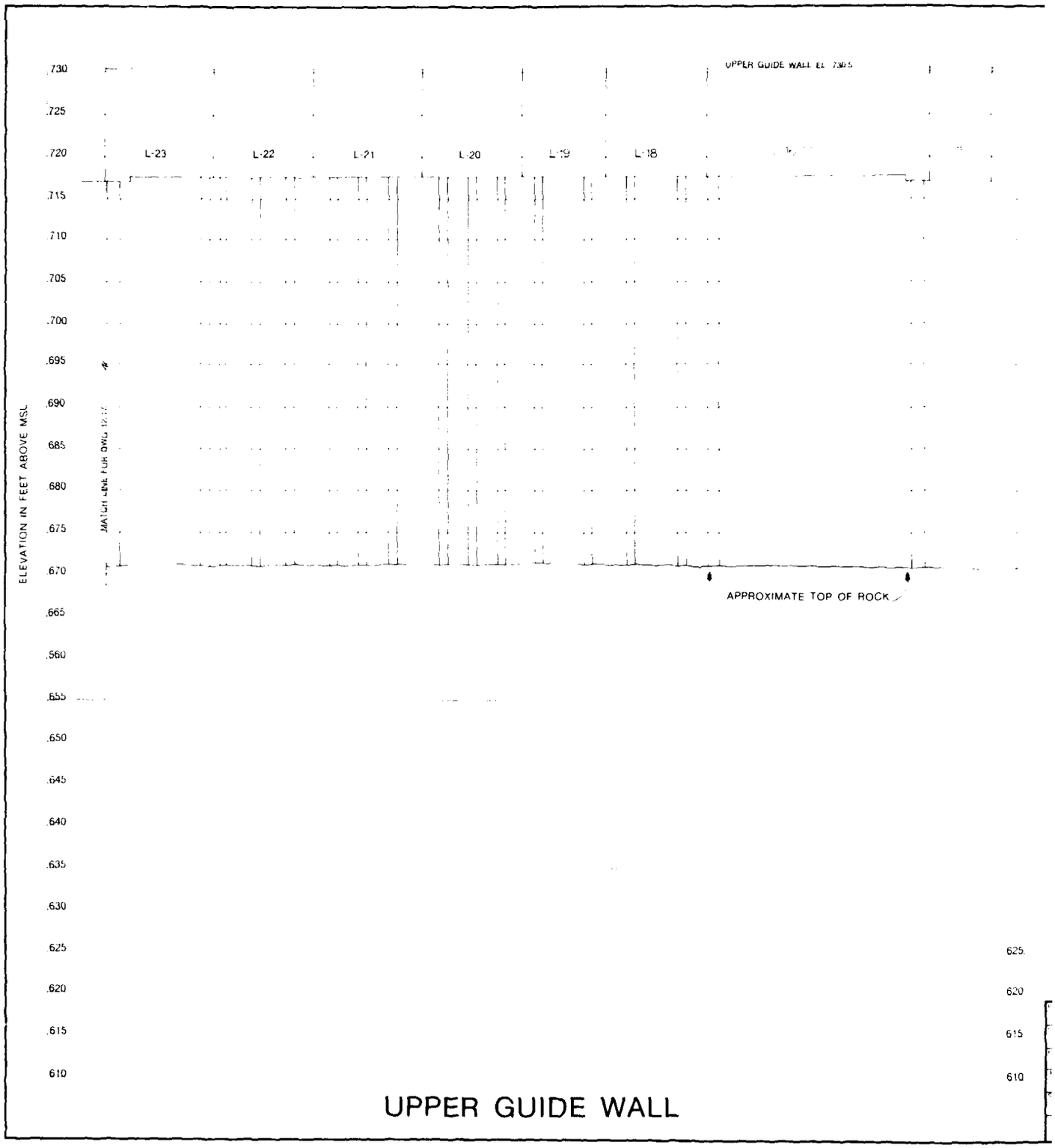
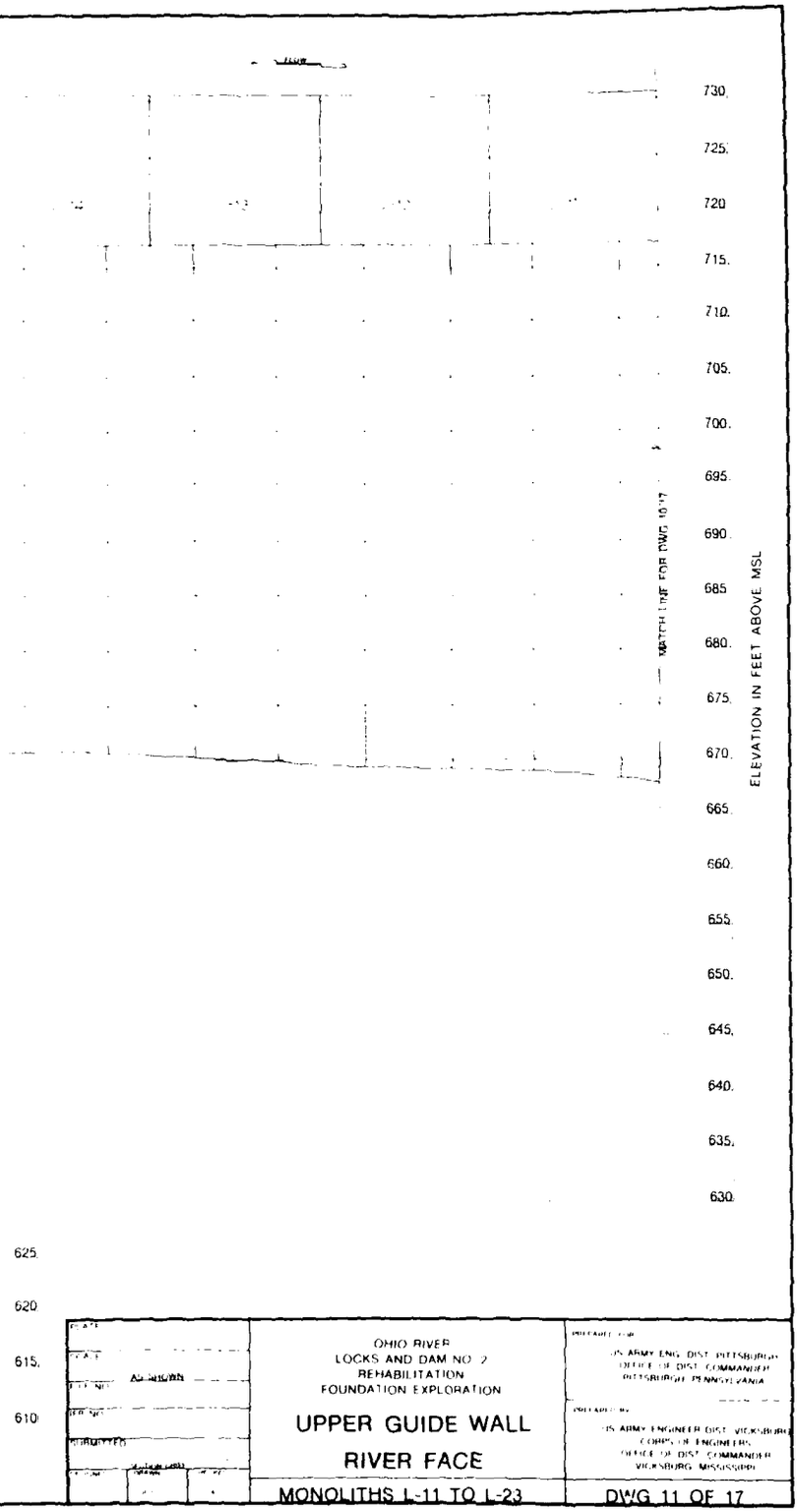

L-4
L-3
L-2
L-1
730
725
720
715
710
705
700
695
690
685
680
675
670
665
660
655
650
645
640
635
630
625
620
615
610
ELEVATION IN FEET ABOVE MSL
OHIO RIVER
LOCKS AND DAM NO. 2
REHABILITATION
FOUNDATION EXPLORATION
UPPER GUIDE WALL
RIVER FACE
MONOLITHS L-1 TO L-10
DWG 10 OF 17

PLATE 13



UPPER GUIDE WALL



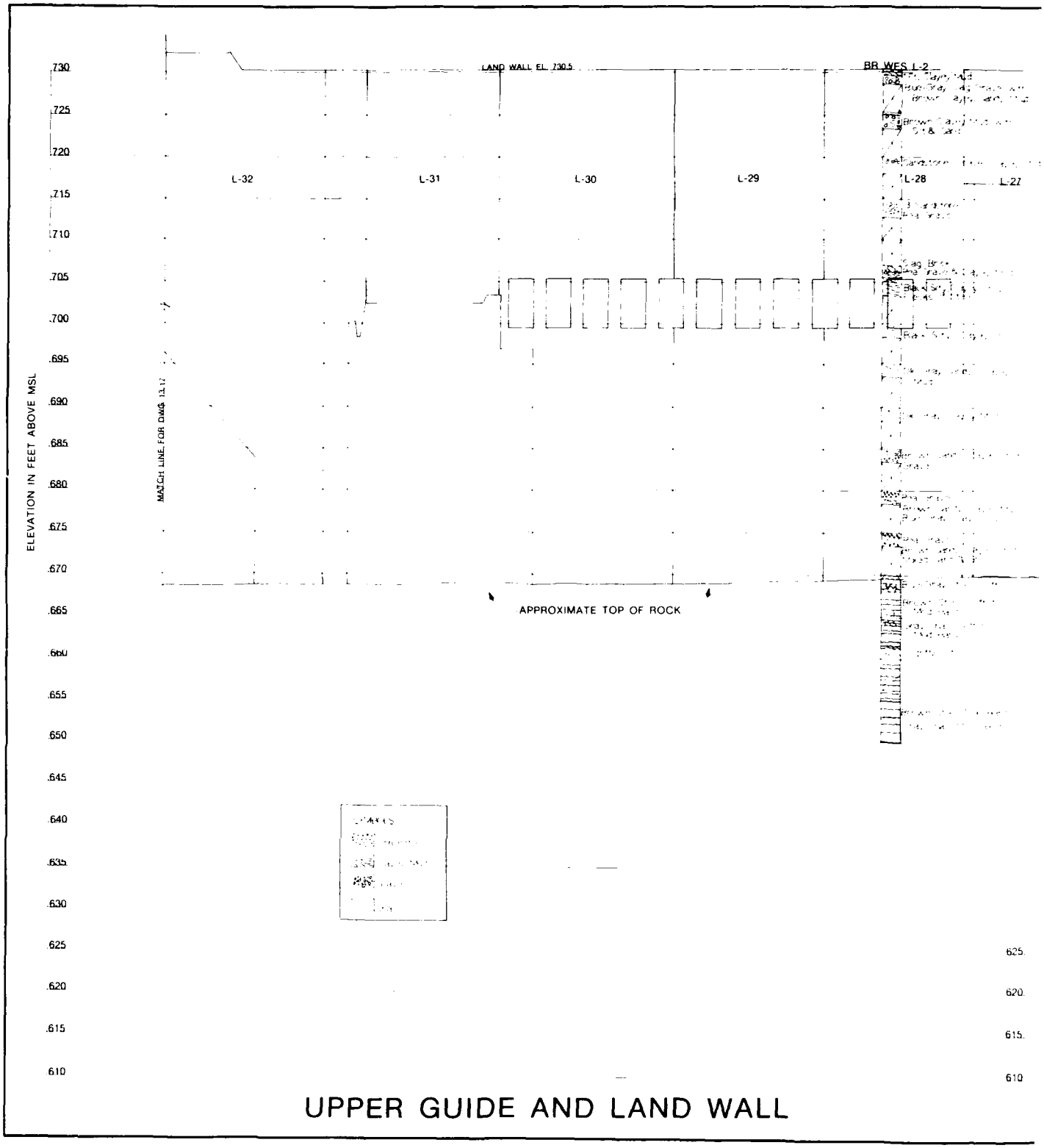
OHIO RIVER
LOCKS AND DAM NO. 2
REHABILITATION
FOUNDATION EXPLORATION

UPPER GUIDE WALL
RIVER FACE

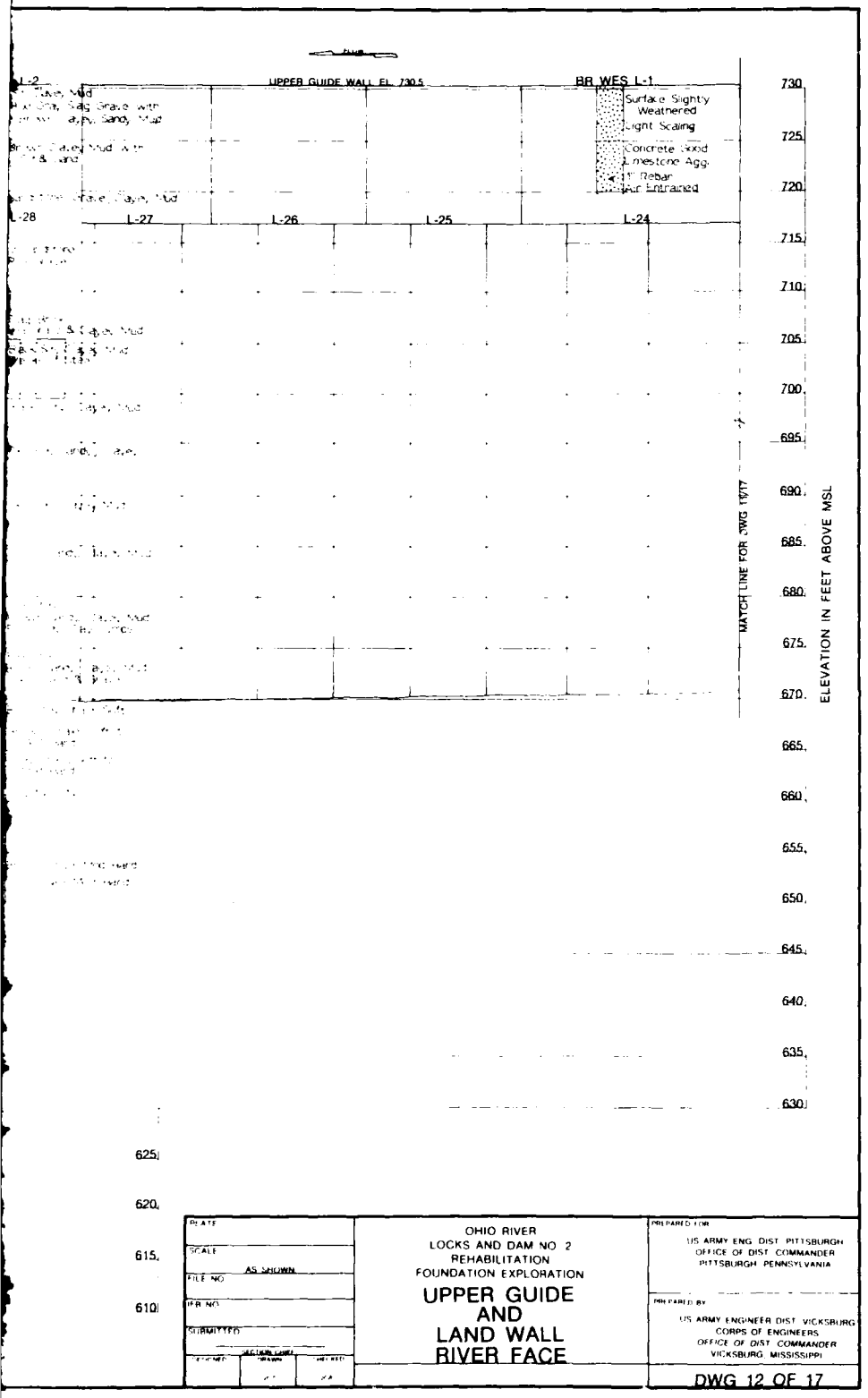
MONOLITHS L-11 TO L-23

DWG 11 OF 17

PLATE 14



UPPER GUIDE AND LAND WALL



PLATE

SCALE AS SHOWN

FILE NO.

DR NO.

SUBMITTED

OHIO RIVER
LOCKS AND DAM NO. 2
REHABILITATION
FOUNDATION EXPLORATION

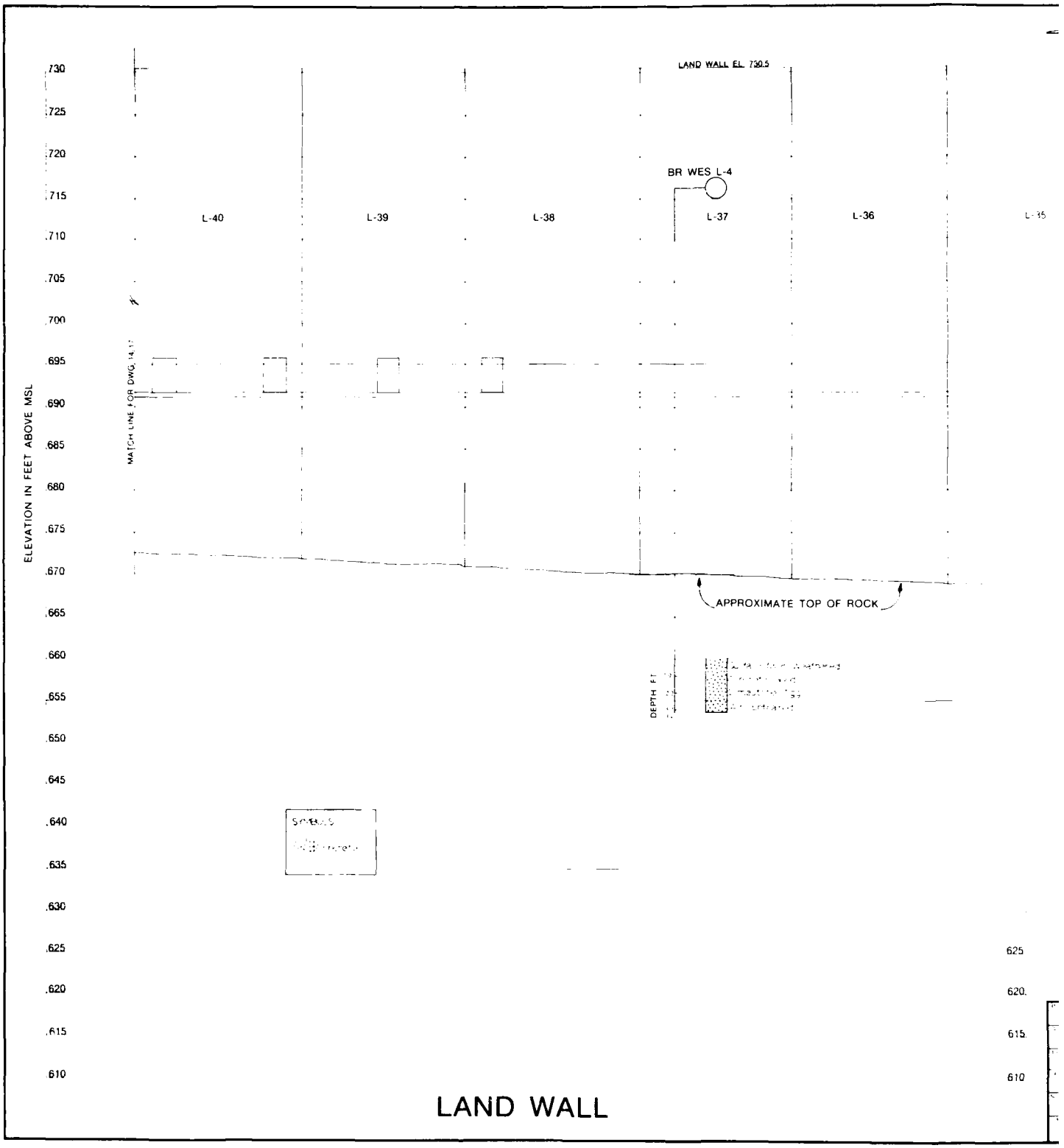
UPPER GUIDE AND LAND WALL RIVER FACE

PREPARED FOR
US ARMY ENG. DIST. PITTSBURGH
OFFICE OF DIST. COMMANDER
PITTSBURGH, PENNSYLVANIA

PREPARED BY
US ARMY ENGINEER DIST. VICKSBURG
CORPS OF ENGINEERS
OFFICE OF DIST. COMMANDER
VICKSBURG, MISSISSIPPI

DWG 12 OF 17

PLATE 15


LAND WALL EL. 730.5
BR WES L-4
L-40
L-39
L-38
L-37
L-36
L-35
MATCH LINE FOR DWG. 14-17
ELEVATION IN FEET ABOVE MSL
730
725
720
715
710
705
700
695
690
685
680
675
670
665
660
655
650
645
640
635
630
625
620
615
610
APPROXIMATE TOP OF ROCK
DEPTH FT
625
620
615
610

LAND WALL

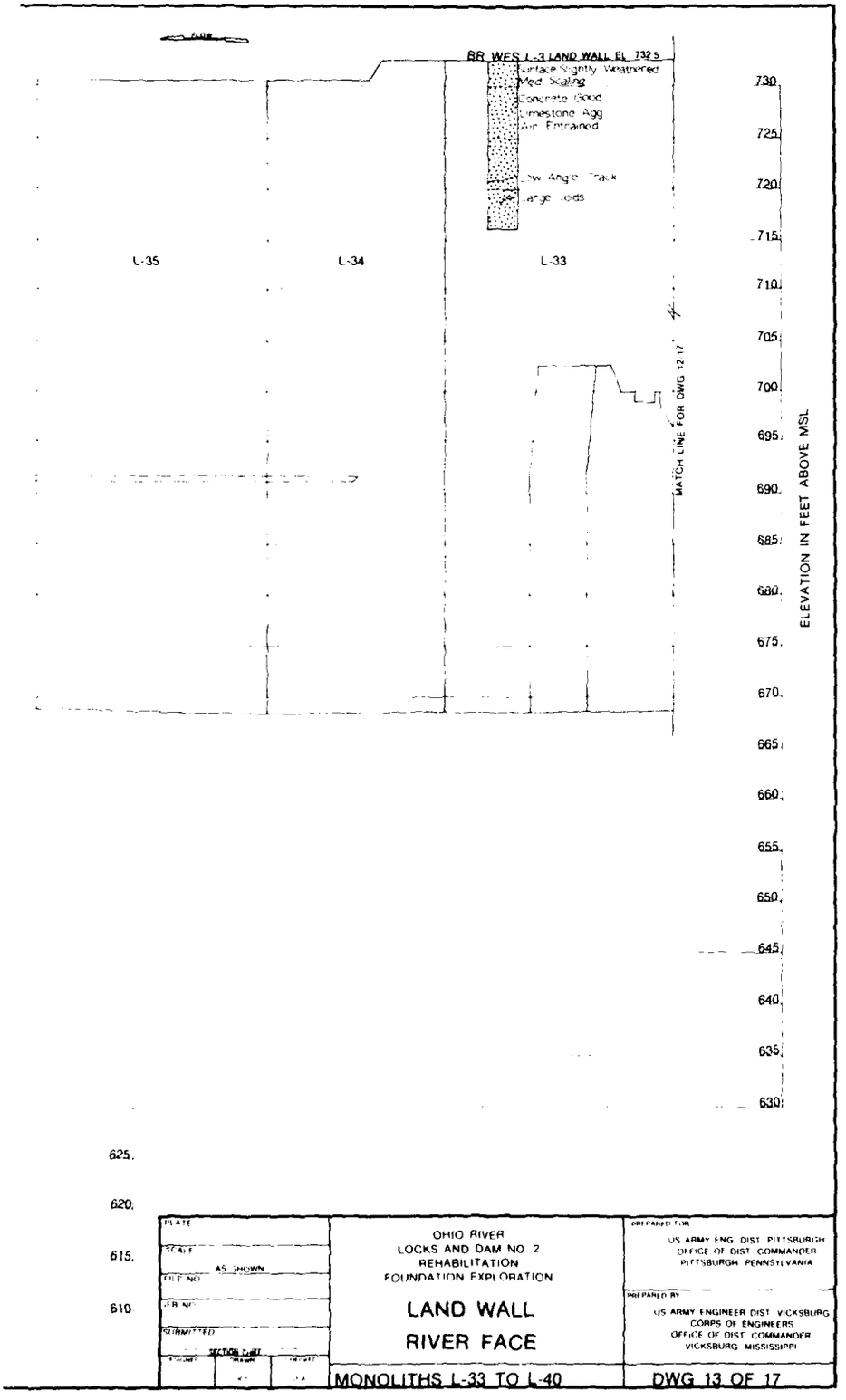
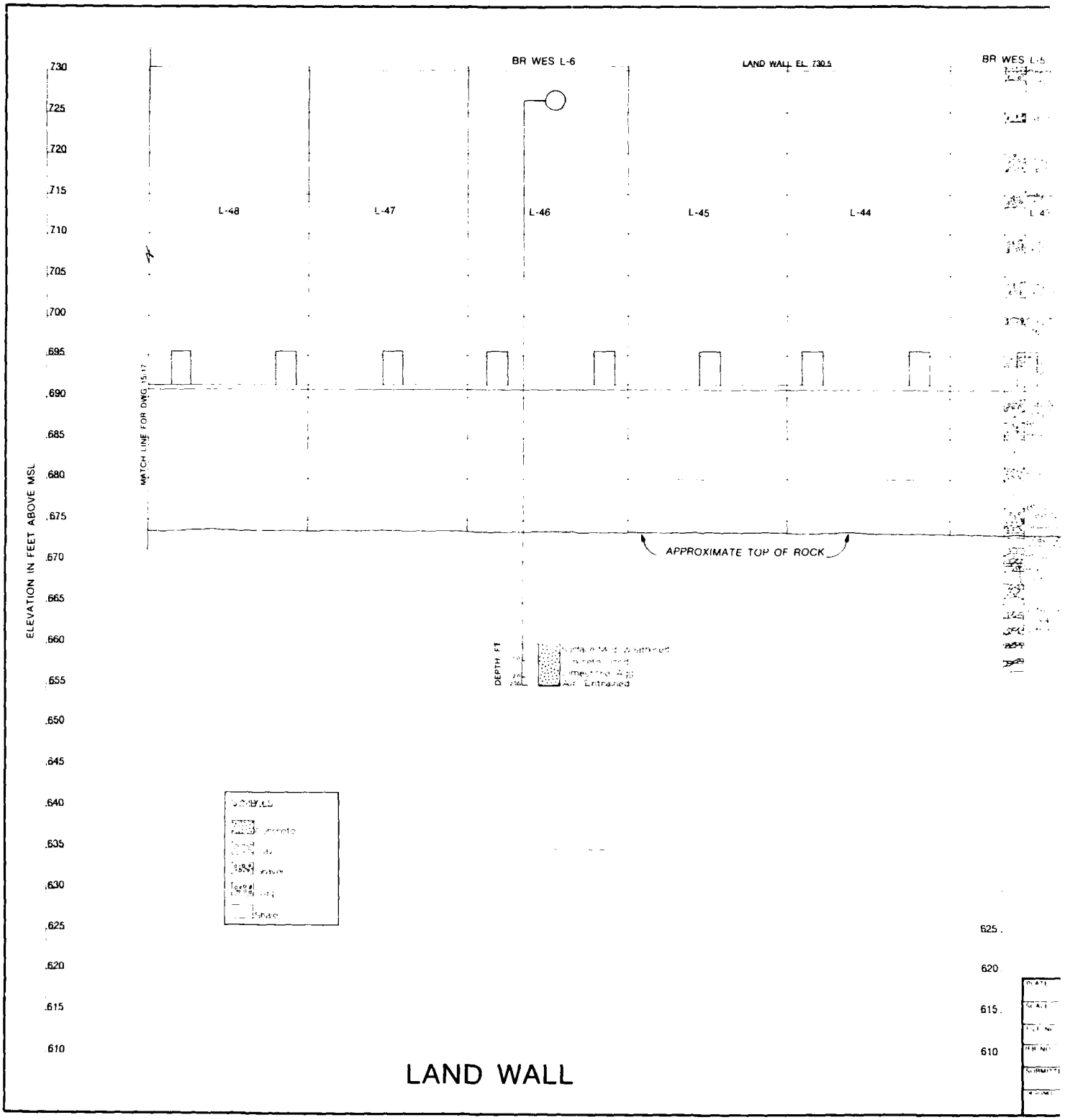

FLOW
BR WES L-3 LAND WALL EL 732.5
Surface Slightly Weathered
Med Scaling
Concrete (Good
Limestone Agg
Air Entrained
Low Angle Track
Large Voids
L-35
L-34
L-33
MATCH LINE FOR DWG 12 17
730.
725.
720.
715.
710.
705.
700.
695.
690.
685.
680.
675.
670.
665.
660.
655.
650.
645.
640.
635.
630.
625.
620.
615.
610.
ELEVATION IN FEET ABOVE MSL
PLATE
SCALE
AS SHOWN
FILE NO.
SUBMITTED
OHIO RIVER
LOCKS AND DAM NO 2
REHABILITATION
FOUNDATION EXPLORATION
LAND WALL
RIVER FACE
MONOLITHS L-33 TO L-40
PREPARED FOR
US ARMY ENG DIST PITTSBURGH
OFFICE OF DIST COMMANDER
PITTSBURGH PENNSYLVANIA
PREPARED BY
US ARMY ENGINEER DIST VICKSBURG
CORPS OF ENGINEERS
OFFICE OF DIST COMMANDER
VICKSBURG MISSISSIPPI
DWG 13 OF 17

PLATE 16


BR WES L-6
LAND WALL EL 730.5
BR WES L-5
L-48
L-47
L-46
L-45
L-44
730
725
720
715
710
705
700
695
690
685
680
675
670
665
660
655
650
645
640
635
630
625
620
615
610
ELEVATION IN FEET ABOVE MSL
MATCH LINE FOR DWG 15-17
APPROXIMATE TOP OF ROCK
DEPTH FT

LAND WALL

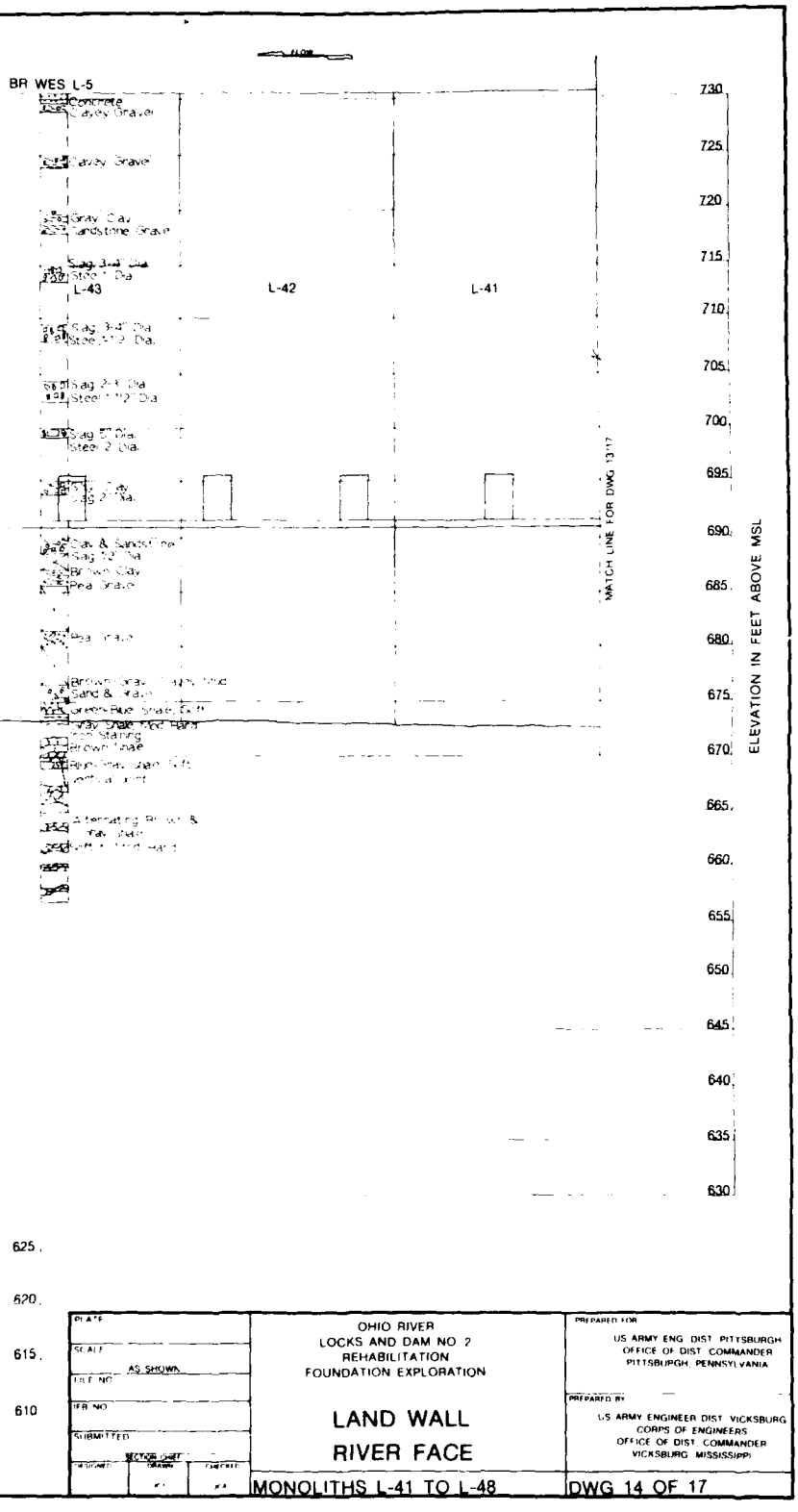
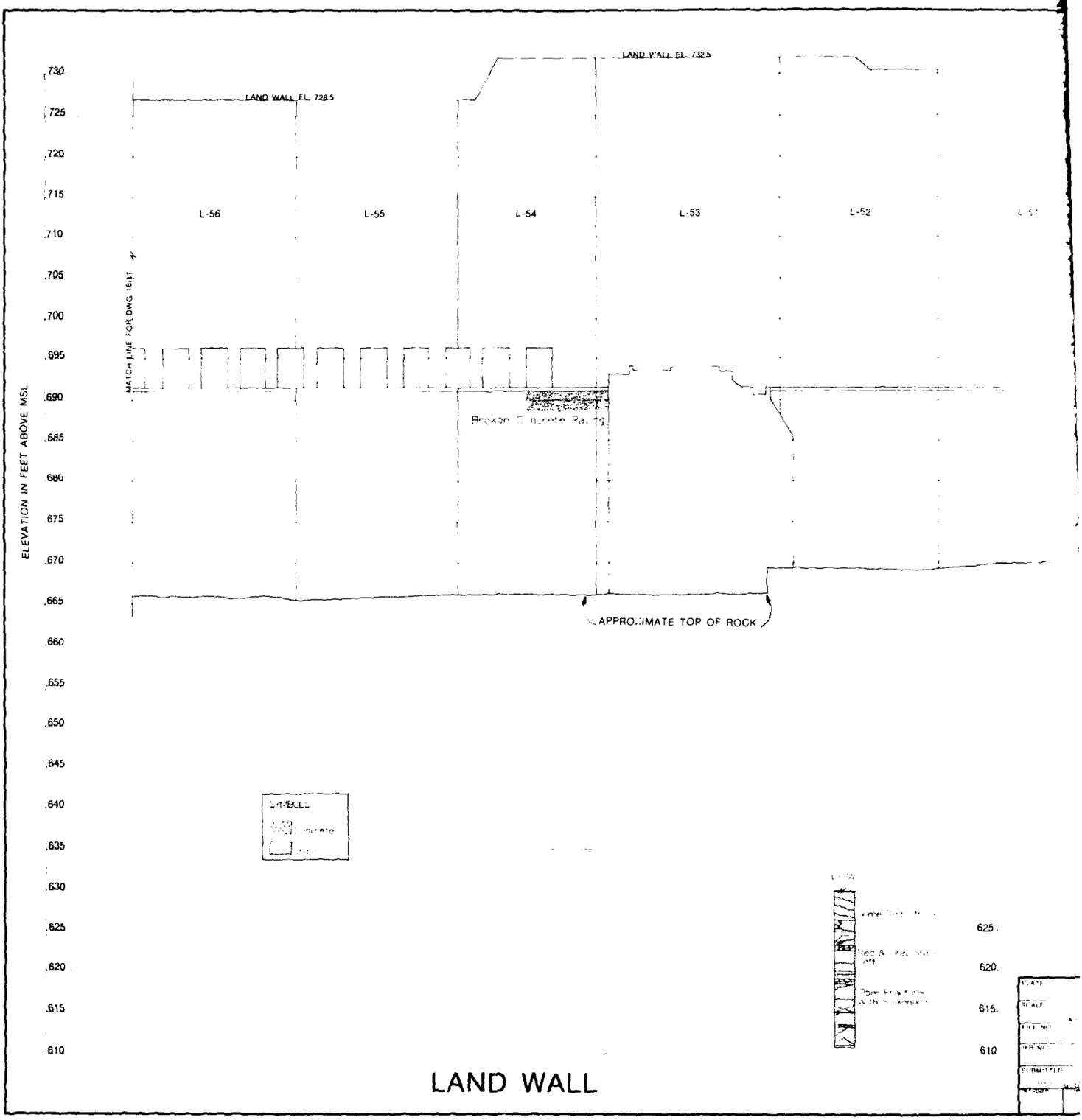


PLATE		OHIO RIVER LOCKS AND DAM NO 2 REHABILITATION FOUNDATION EXPLORATION	PREPARED FOR US ARMY ENG DIST PITTSBURGH OFFICE OF DIST COMMANDER PITTSBURGH, PENNSYLVANIA
SCALE	AS SHOWN		
DWG NO			PREPARED BY US ARMY ENGINEER DIST VICKSBURG CORPS OF ENGINEERS OFFICE OF DIST COMMANDER VICKSBURG, MISSISSIPPI
IFB NO		LAND WALL RIVER FACE	
SUBMITTED			
SECTION CHIEF			
DESIGNED	DRAWN	CHECKED	
		MONOLITHS L-41 TO L-48	DWG 14 OF 17

PLATE 17


LAND WALL EL. 728.5
LAND WALL EL. 732.5
L-56
L-55
L-54
L-53
L-52
MATCH LINE FOR DWG 1617
APPROXIMATE TOP OF ROCK
ELEVATION IN FEET ABOVE MSL
730
725
720
715
710
705
700
695
690
685
680
675
670
665
660
655
650
645
640
635
630
625
620
615
610

LAND WALL

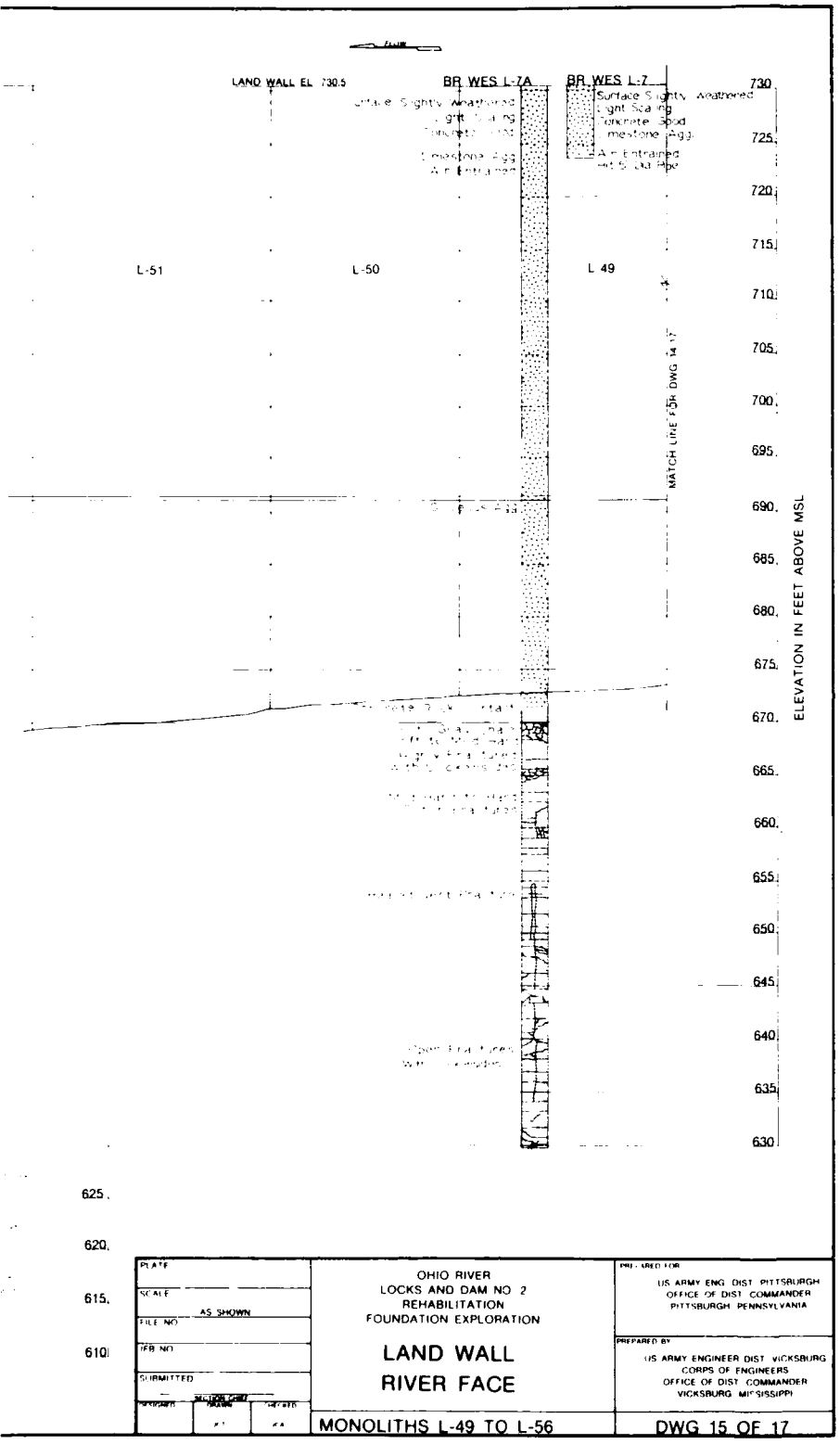
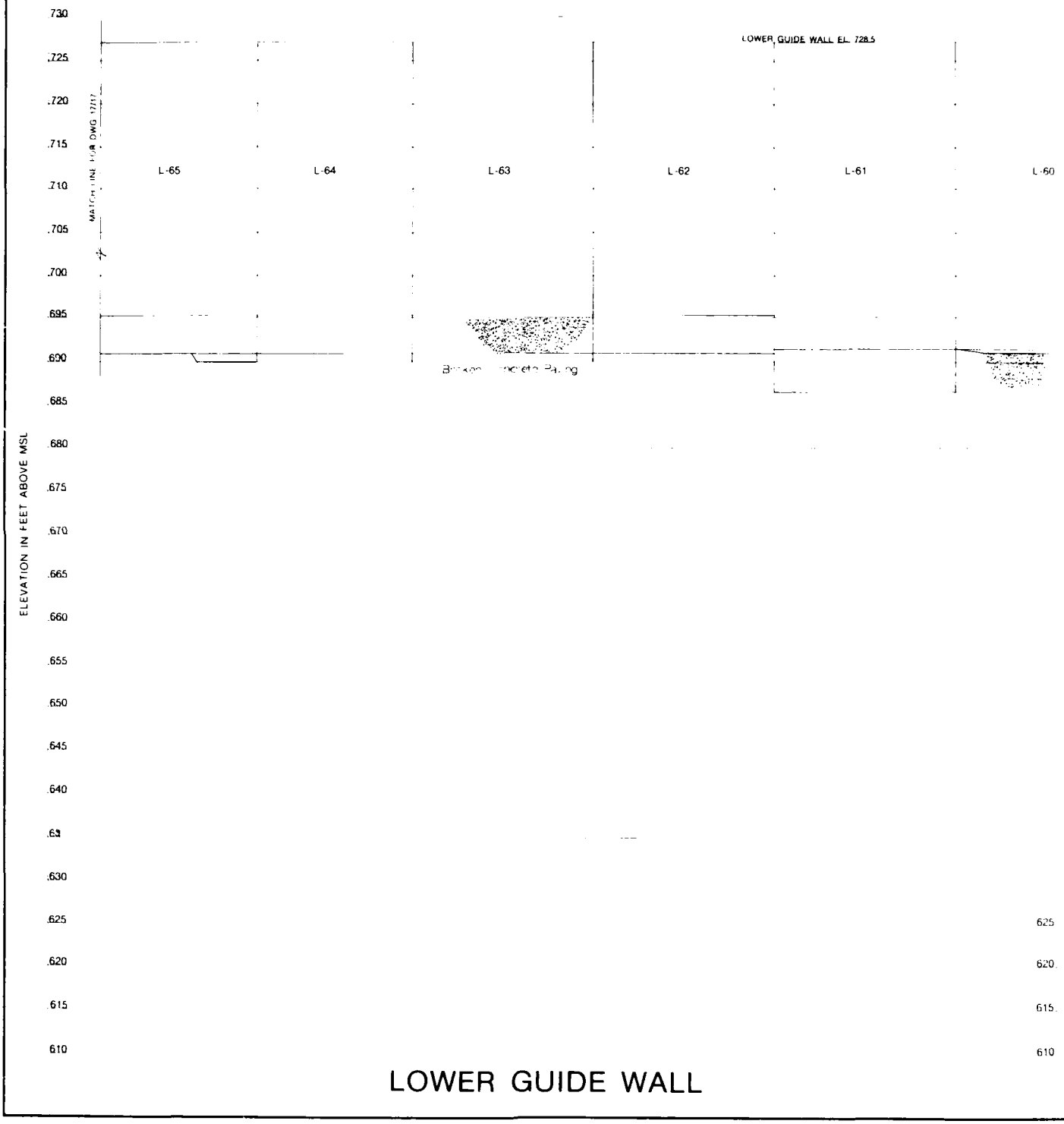


PLATE SCALE AS SHOWN FILE NO JOB NO SUBMITTED	OHIO RIVER LOCKS AND DAM NO 2 REHABILITATION FOUNDATION EXPLORATION **LAND WALL** **RIVER FACE**	PREPARED FOR US ARMY ENG DIST PITTSBURGH OFFICE OF DIST COMMANDER PITTSBURGH PENNSYLVANIA PREPARED BY US ARMY ENGINEER DIST VICKSBURG CORPS OF ENGINEERS OFFICE OF DIST COMMANDER VICKSBURG MISSISSIPPI
	MONOLITHS L-49 TO L-56	DWG 15 OF 17

PLATE 18



LOWER GUIDE WALL

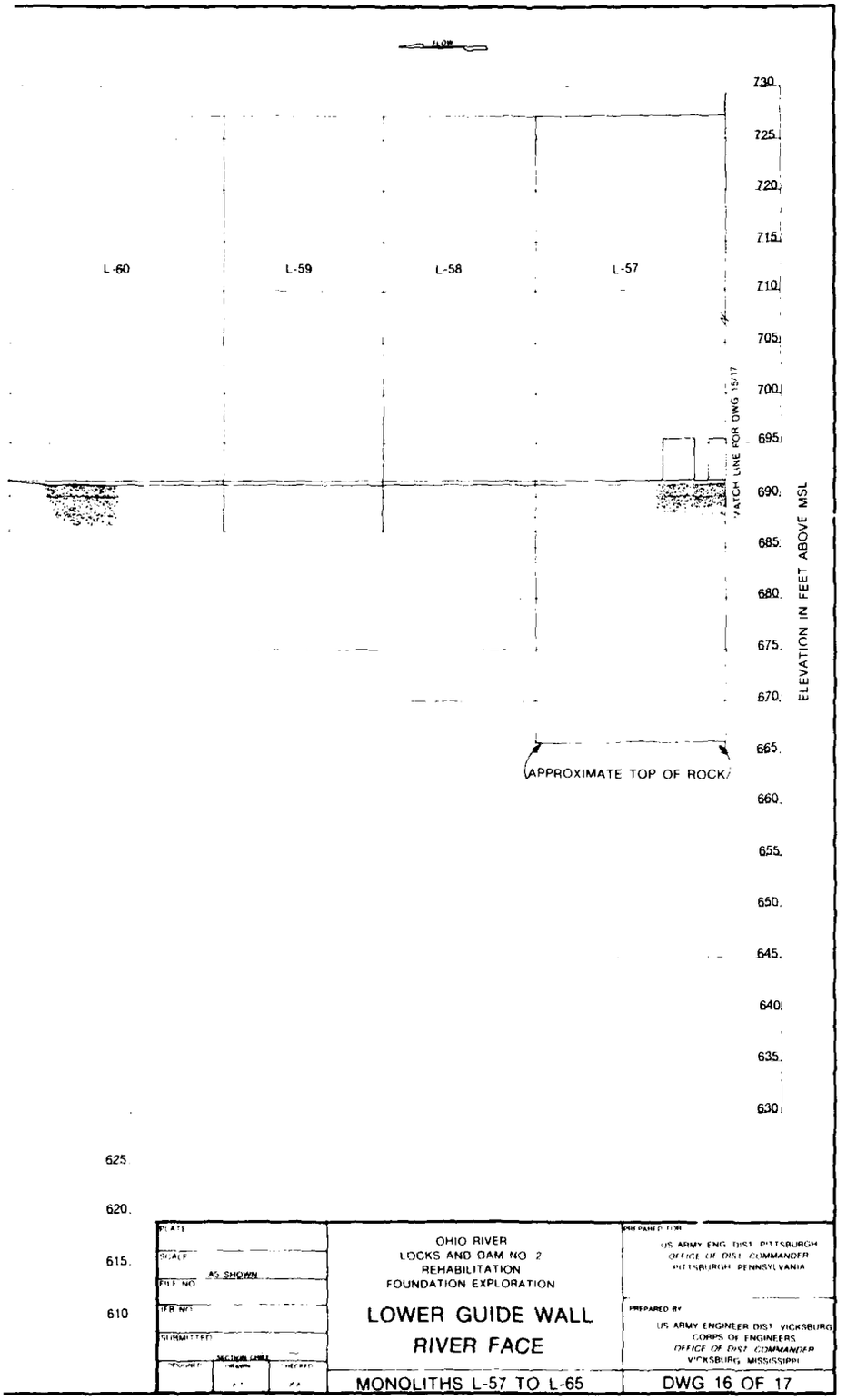
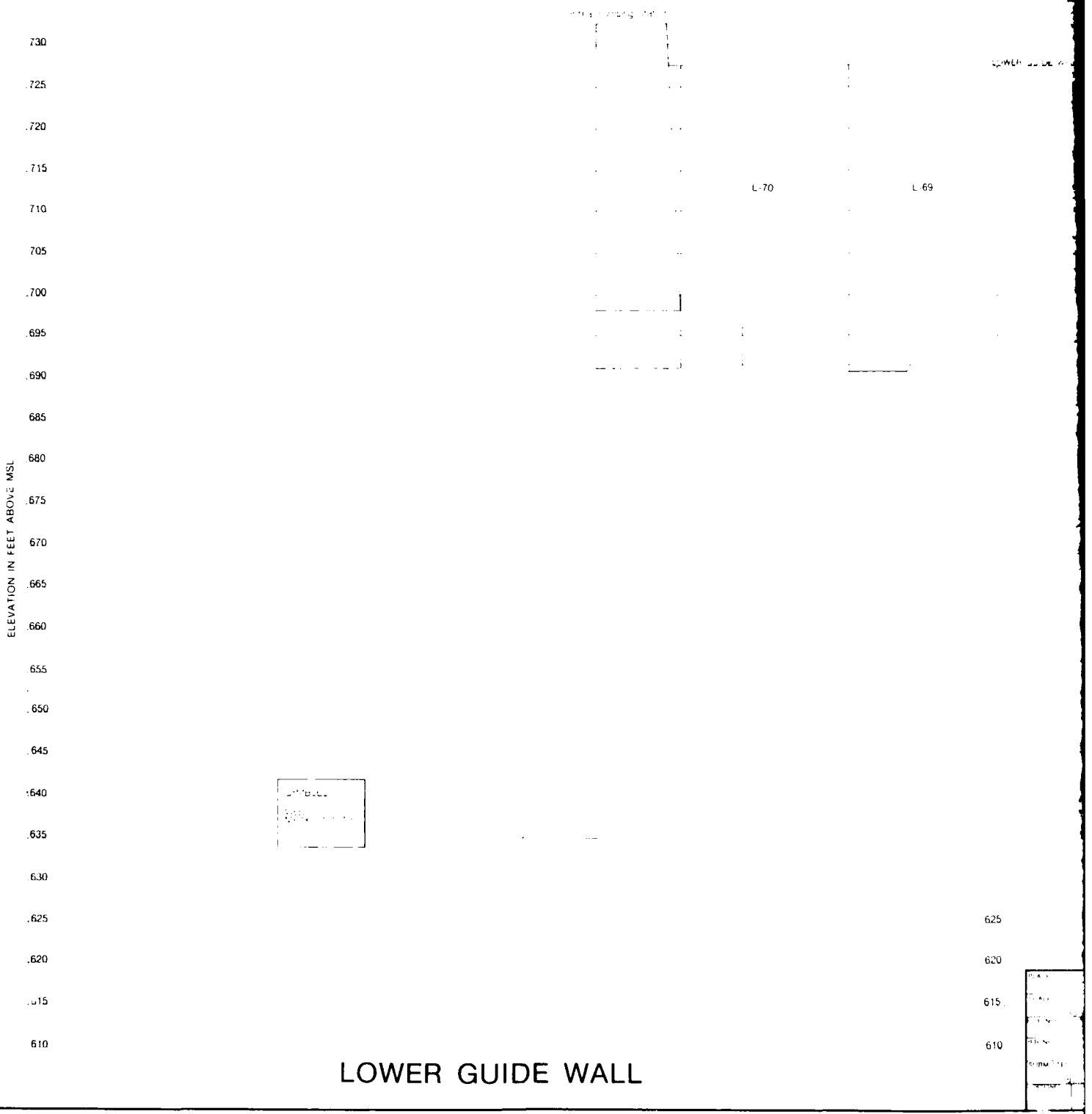

FLOW
L-60
L-59
L-58
L-57
730
725
720
715
710
705
700
695
690
685
680
675
670
665
660
655
650
645
640
635
630
625
620
615
610
MATCH LINE FOR DWG 15/17
ELEVATION IN FEET ABOVE MSL
APPROXIMATE TOP OF ROCK
PLATE
SCALE AS SHOWN
FILE NO
IFB NO
SUBMITTED
SECTION CHIEF
DESIGNED
DRAWN
CHECKED
OHIO RIVER
LOCKS AND DAM NO 2
REHABILITATION
FOUNDATION EXPLORATION
LOWER GUIDE WALL
RIVER FACE
MONOLITHS L-57 TO L-65
PREPARED FOR
US ARMY ENG DIST PITTSBURGH
OFFICE OF DIST COMMANDER
PITTSBURGH PENNSYLVANIA
PREPARED BY
US ARMY ENGINEER DIST VICKSBURG
CORPS OF ENGINEERS
OFFICE OF DIST COMMANDER
VICKSBURG MISSISSIPPI
DWG 16 OF 17

PLATE 19



LOWER GUIDE WALL

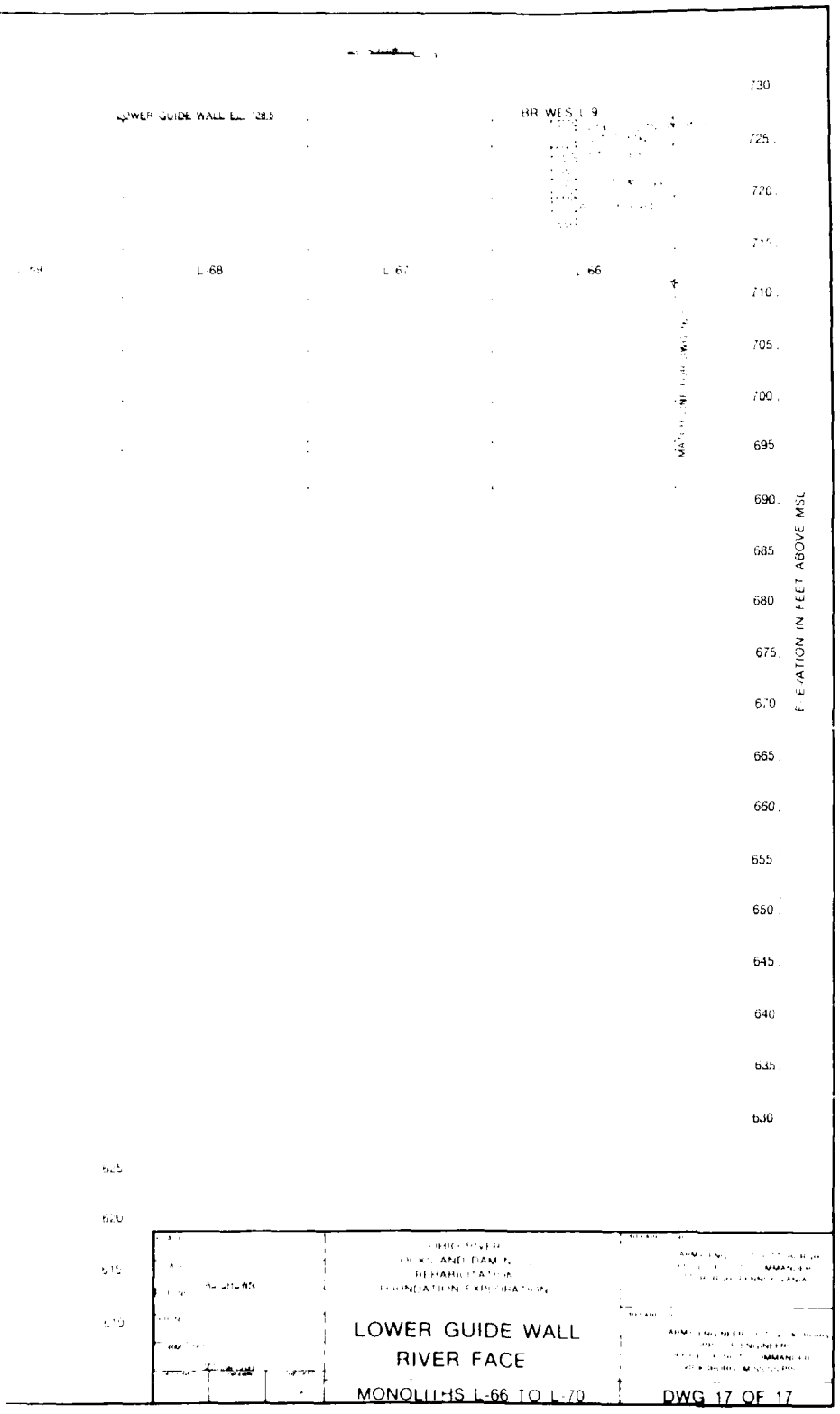
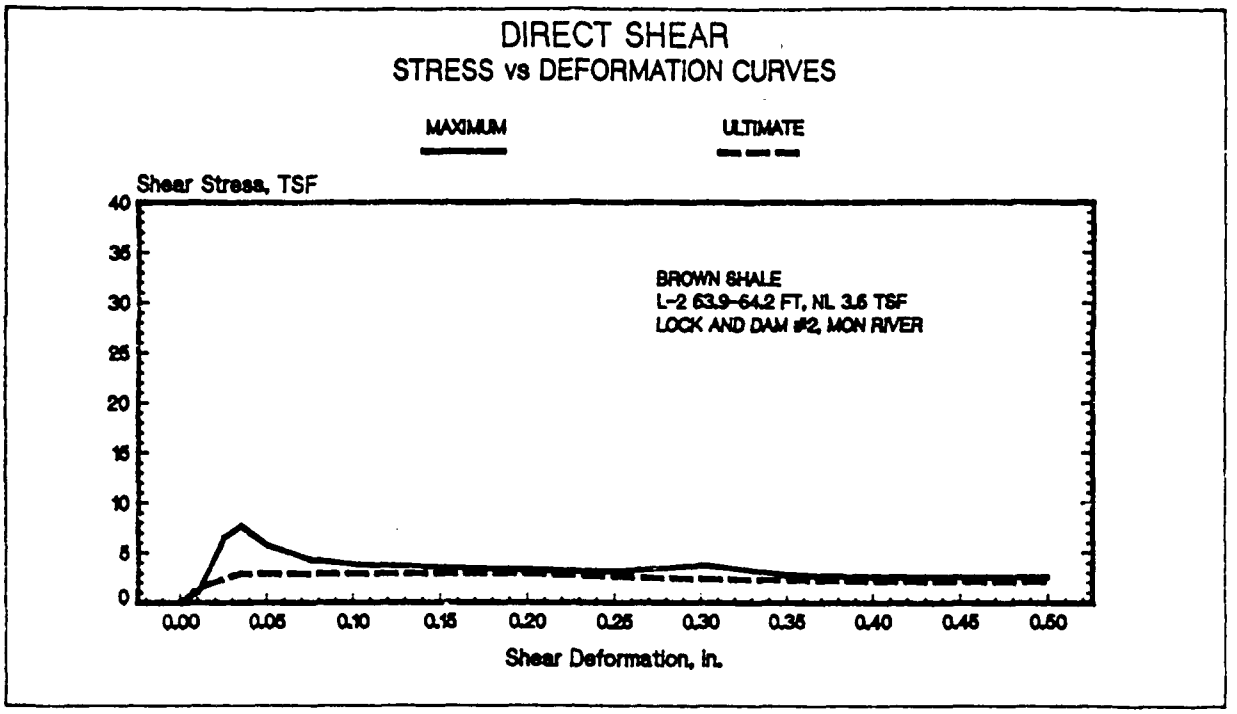
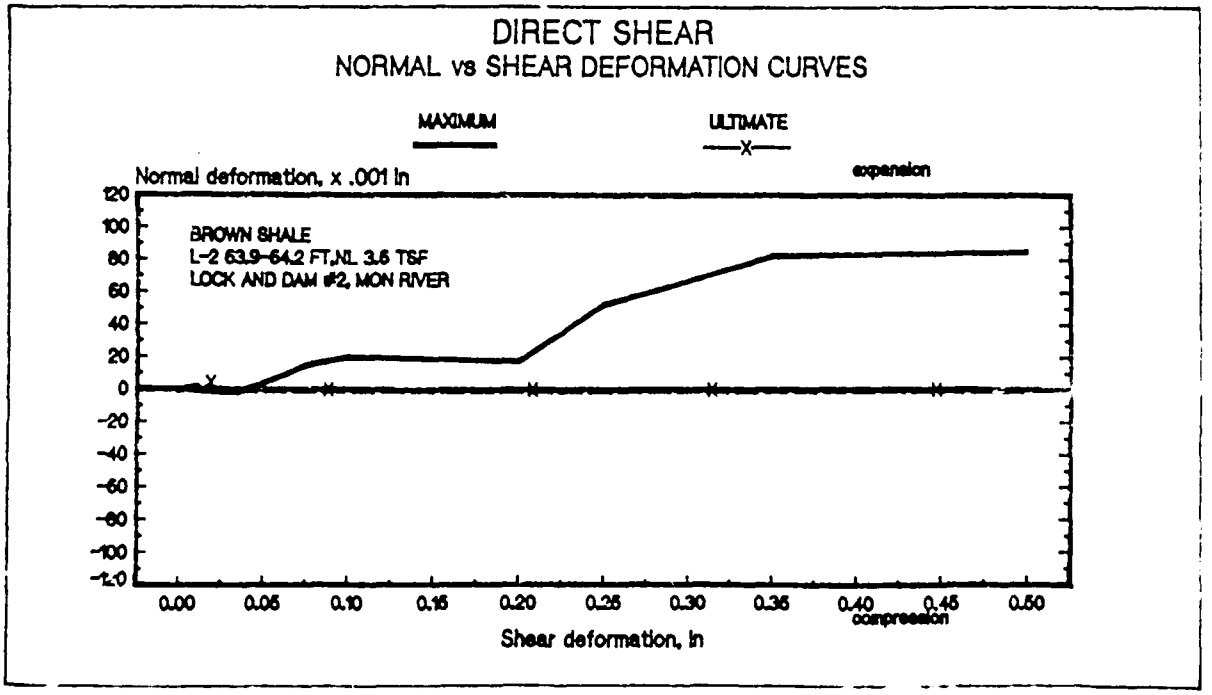
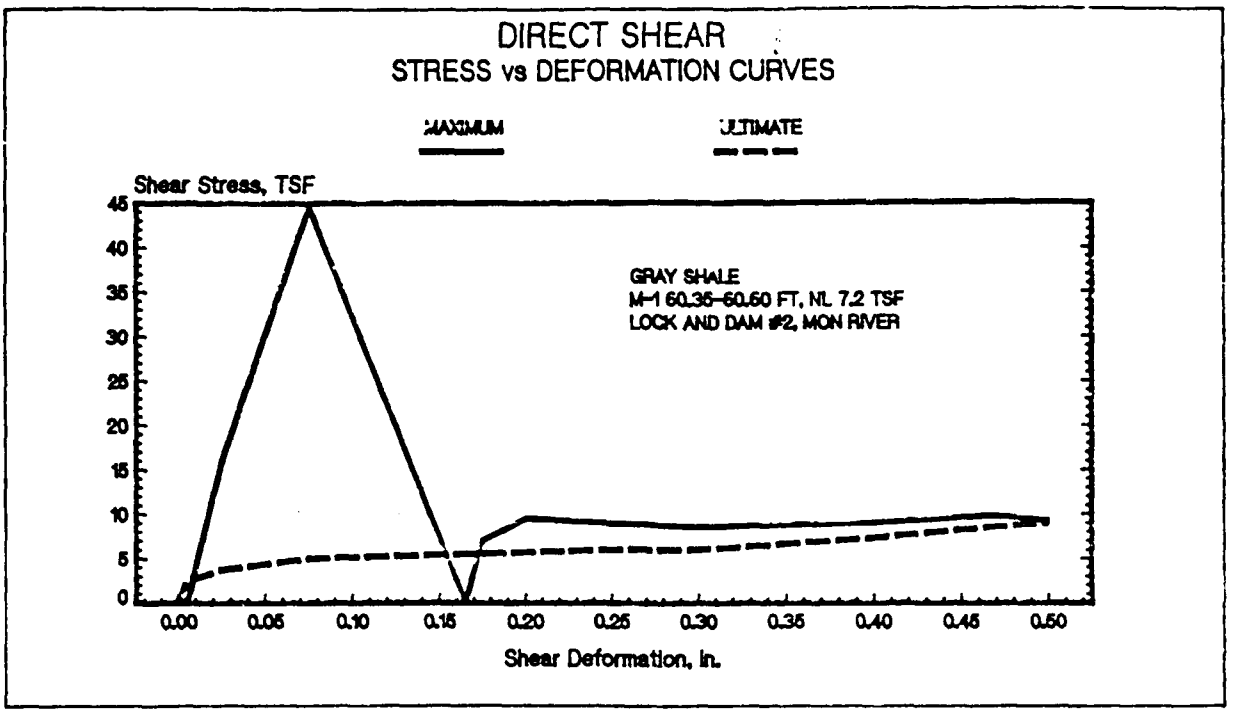
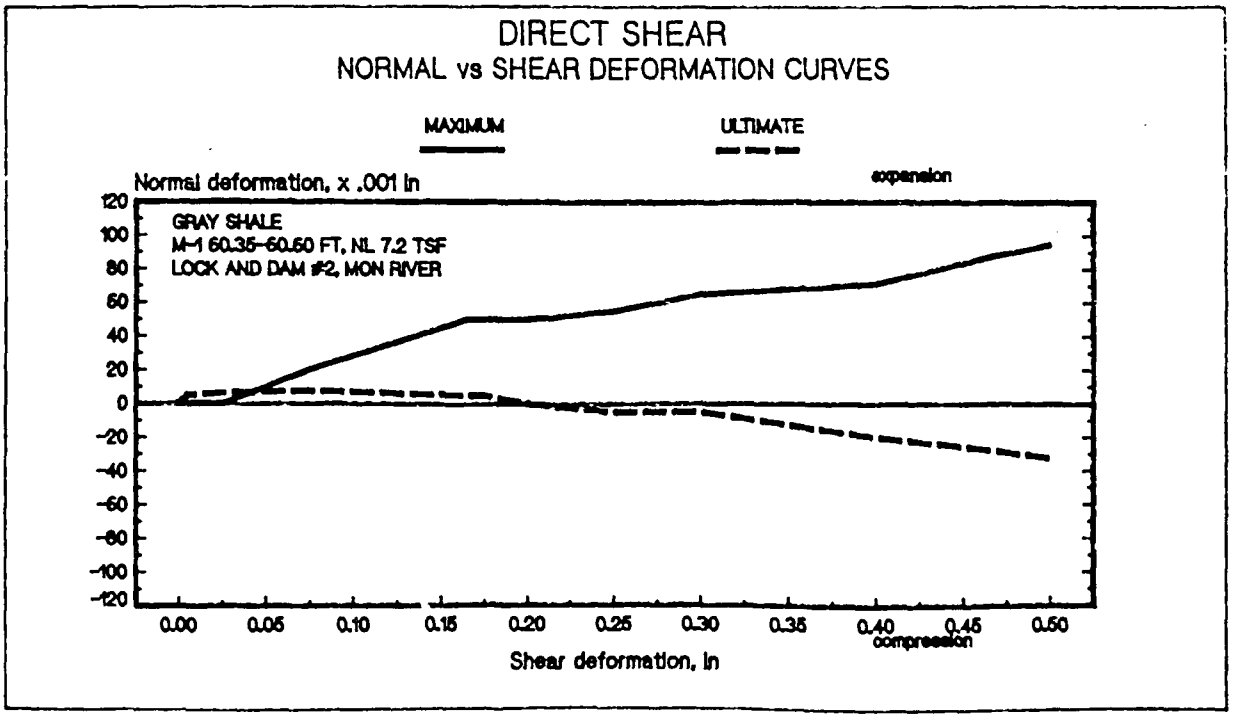

LOWER GUIDE WALL EL. 738.5
BR WES L 9
L-68
L-67
L-66
730
725
720
715
710
705
700
695
690
685
680
675
670
665
660
655
650
645
640
635
630
ELEVATION IN FEET ABOVE MSL
LOWER GUIDE WALL
RIVER FACE
MONOLITHS L-66 TO L-70
DWG 17 OF 17

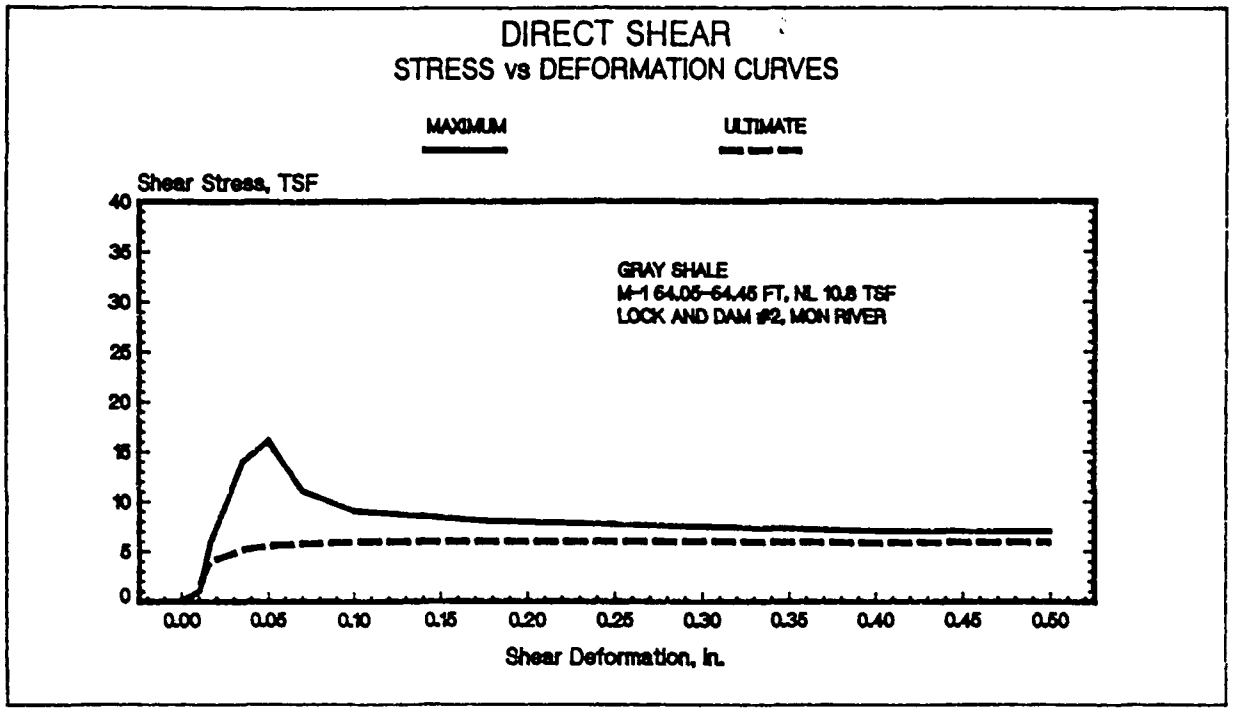
PLATE 20

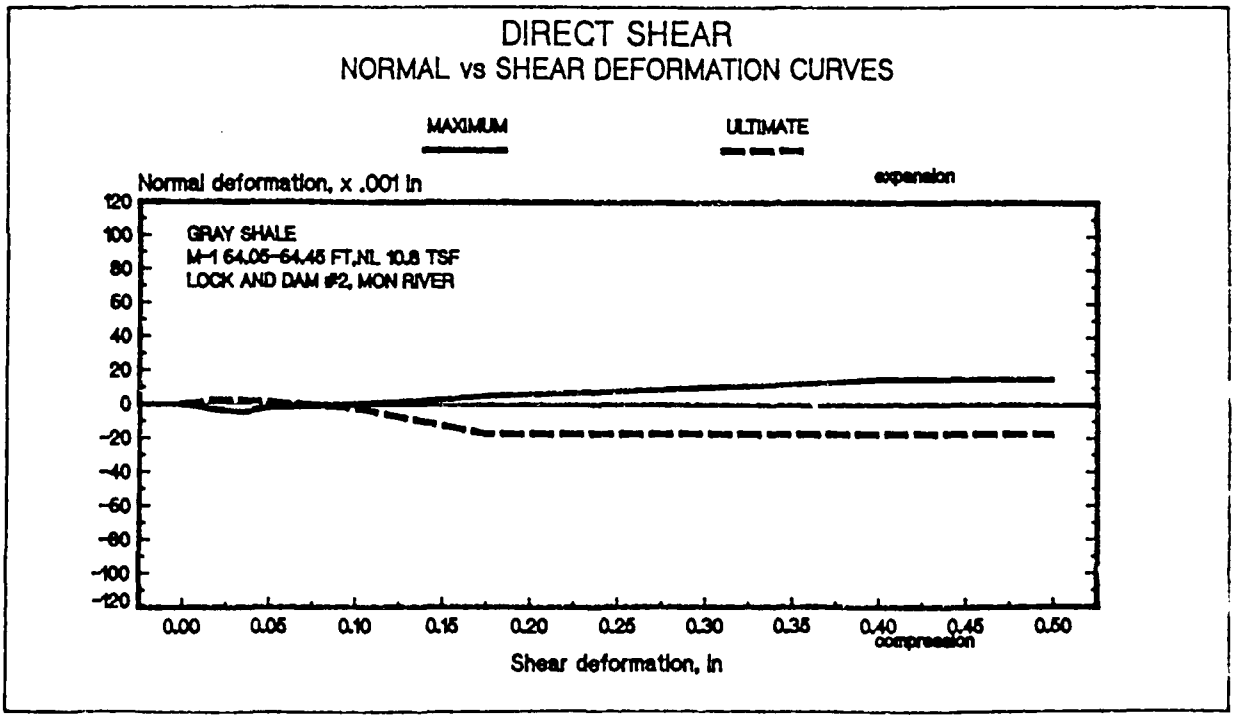

DIRECT SHEAR
STRESS vs DEFORMATION CURVES
MAXIMUM
ULTIMATE
Shear Stress, TSF
40
35
30
25
20
15
10
5
0
BROWN SHALE
L-2 63.9-64.2 FT, NL 3.6 TSF
LOCK AND DAM #2, MON RIVER
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
Shear Deformation, in.

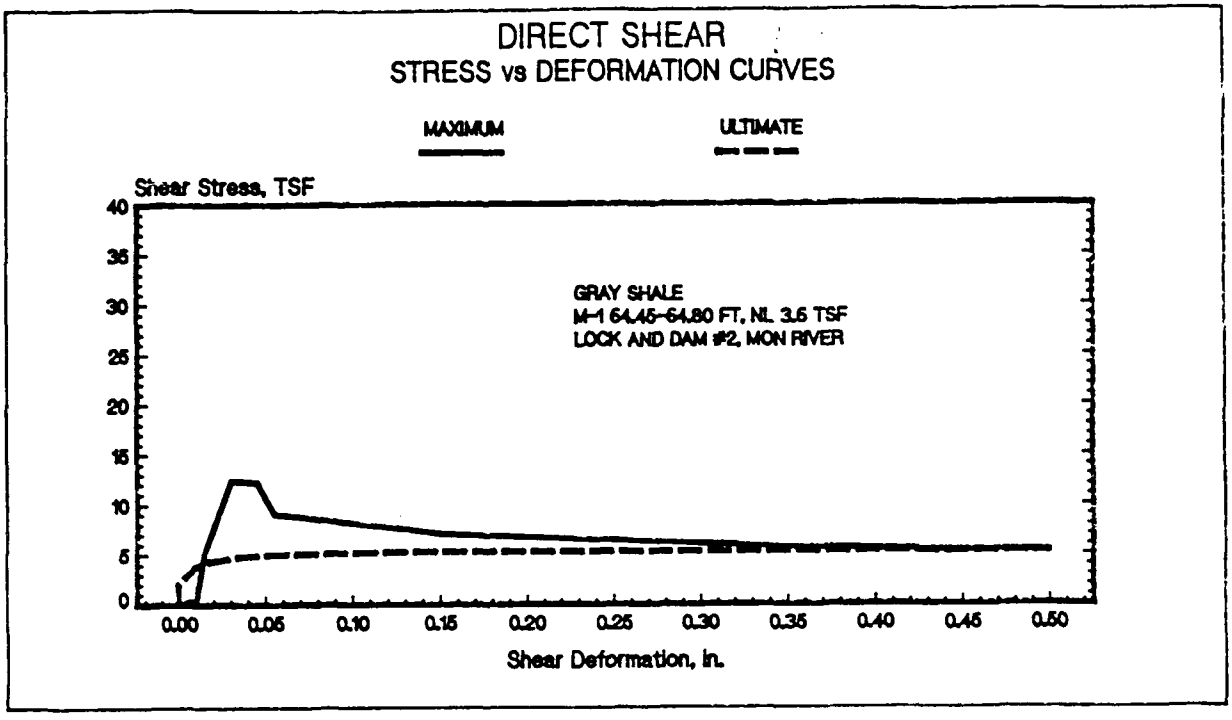

DIRECT SHEAR
NORMAL vs SHEAR DEFORMATION CURVES
MAXIMUM
ULTIMATE
Normal deformation, x .001 in
expansion
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
BROWN SHALE
L-2 63.9-64.2 FT,NL 3.6 TSF
LOCK AND DAM #2, MON RIVER
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
compression
Shear deformation, in

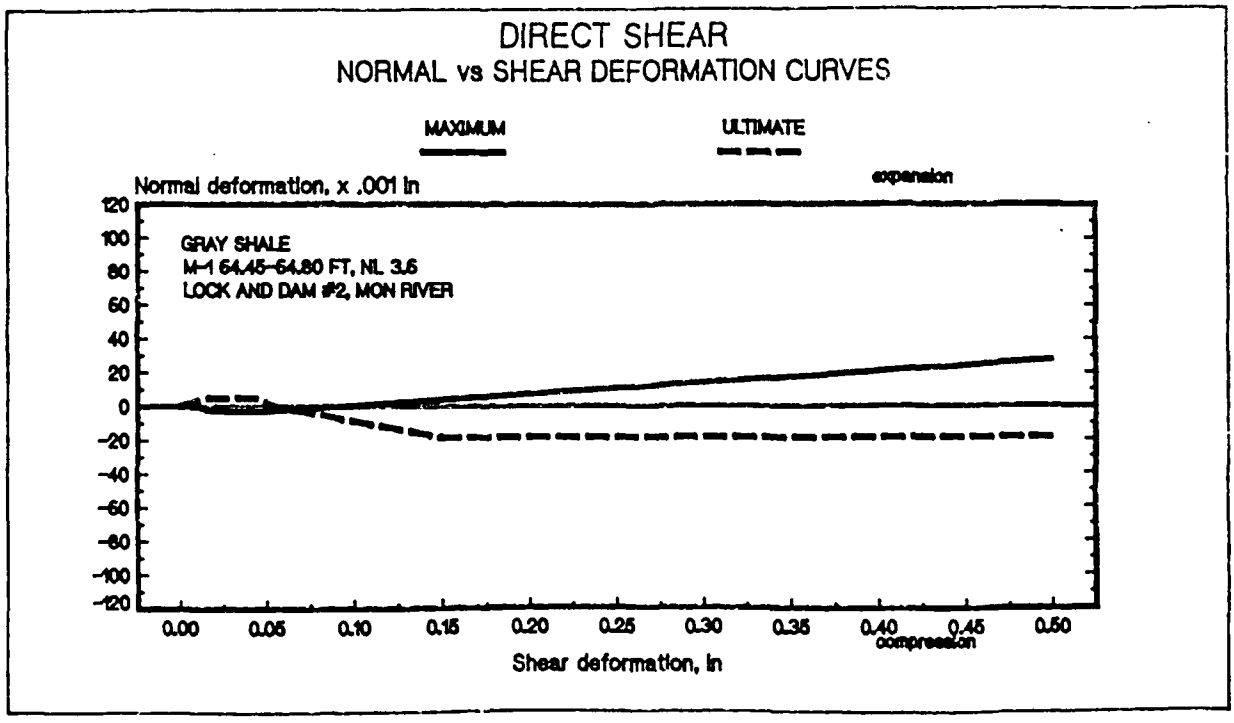

DIRECT SHEAR
STRESS vs DEFORMATION CURVES
MAXIMUM
ULTIMATE
Shear Stress, TSF
45
40
35
30
25
20
15
10
5
0
GRAY SHALE
M-1 60.35-60.60 FT, NL 7.2 TSF
LOCK AND DAM #2, MON RIVER
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
Shear Deformation, in.

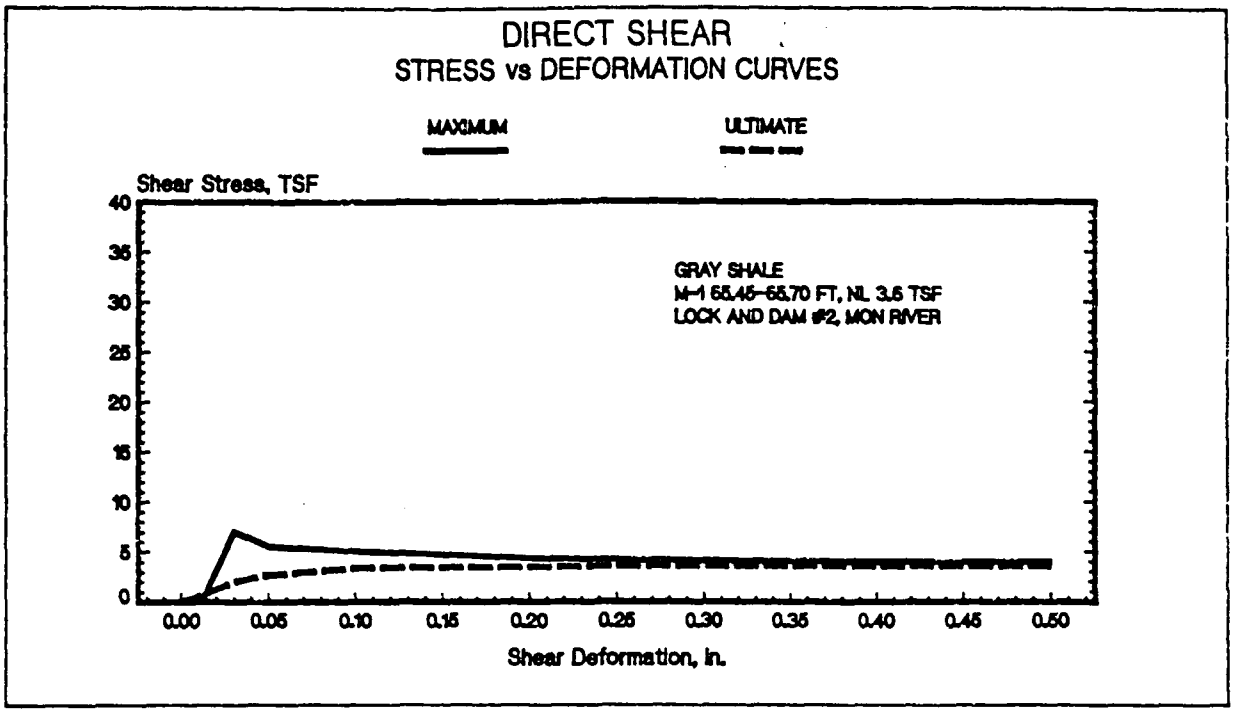

DIRECT SHEAR
NORMAL vs SHEAR DEFORMATION CURVES
MAXIMUM
ULTIMATE
Normal deformation, x .001 in
expansion
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
GRAY SHALE
M-1 60.35-60.60 FT, NL 7.2 TSF
LOCK AND DAM #2, MON RIVER
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
compression
Shear deformation, in

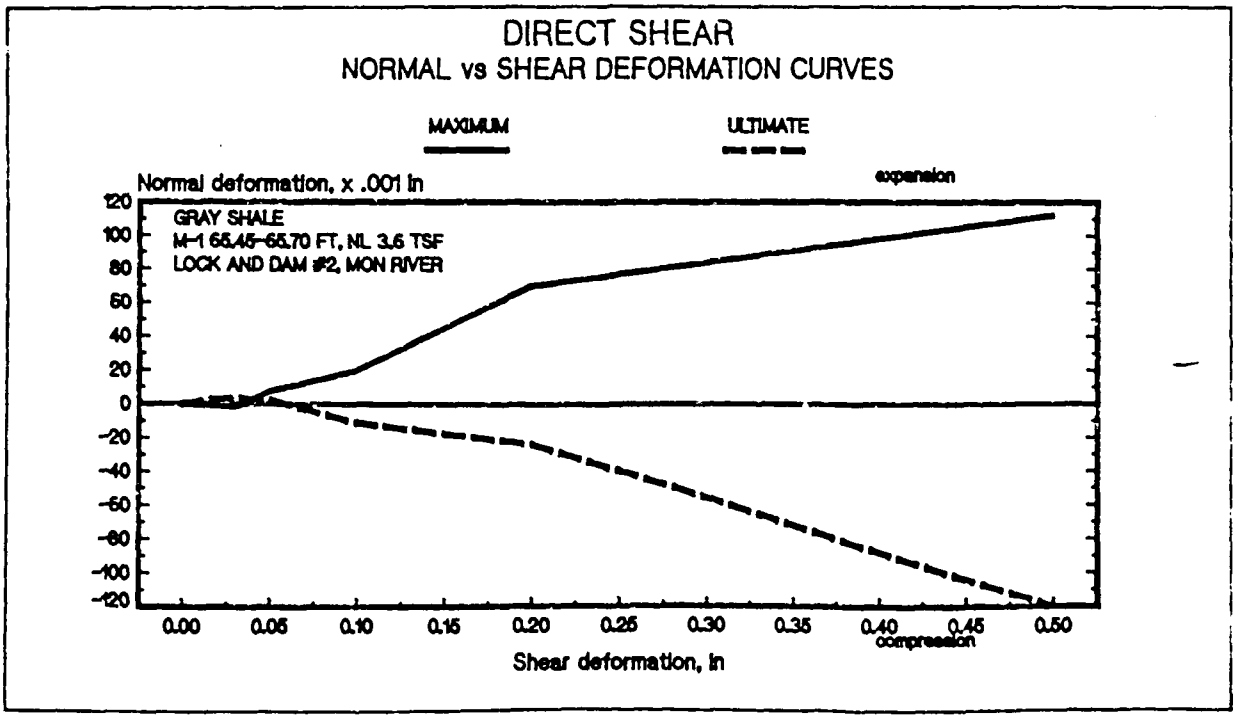

DIRECT SHEAR
STRESS vs DEFORMATION CURVES
MAXIMUM
ULTIMATE
Shear Stress, TSF
40
35
30
25
20
15
10
5
0
GRAY SHALE
M-1 64.05-64.45 FT, NL 10.8 TSF
LOCK AND DAM #2, MON RIVER
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
Shear Deformation, in.

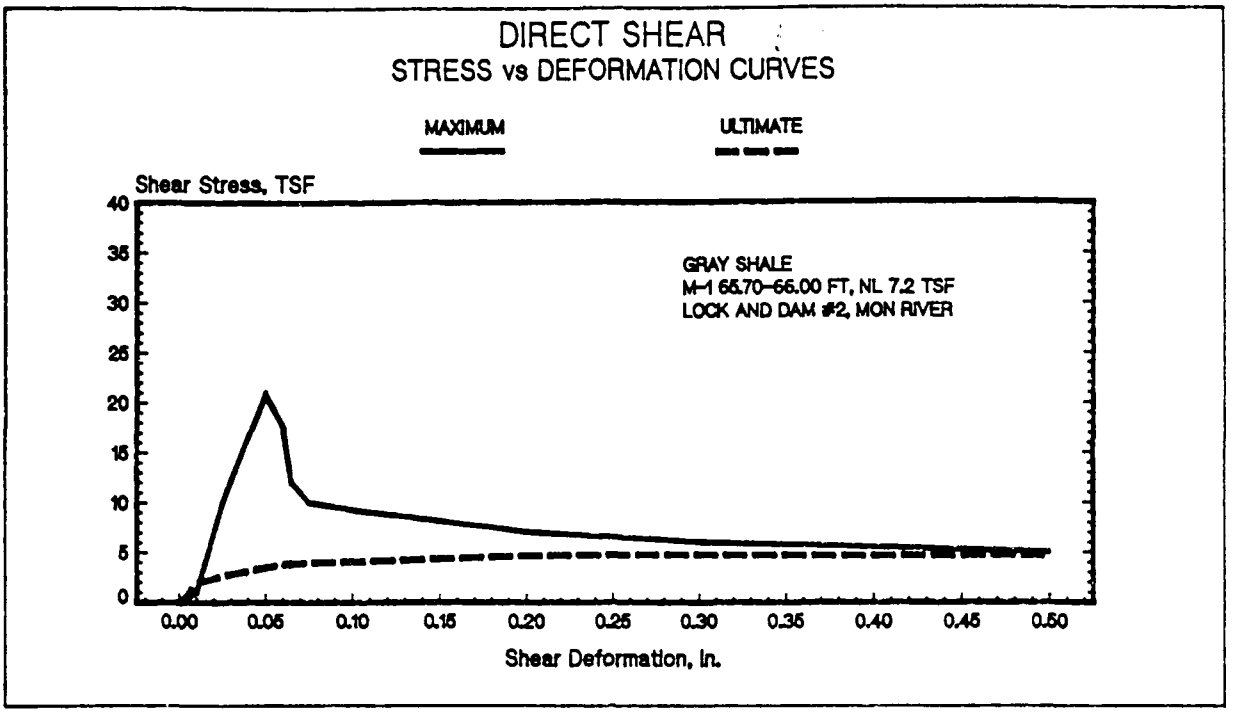

DIRECT SHEAR
NORMAL vs SHEAR DEFORMATION CURVES
MAXIMUM
ULTIMATE
Normal deformation, x .001 in
expansion
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
GRAY SHALE
M-1 64.05-64.45 FT,NL 10.8 TSF
LOCK AND DAM #2, MON RIVER
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
compression
Shear deformation, in

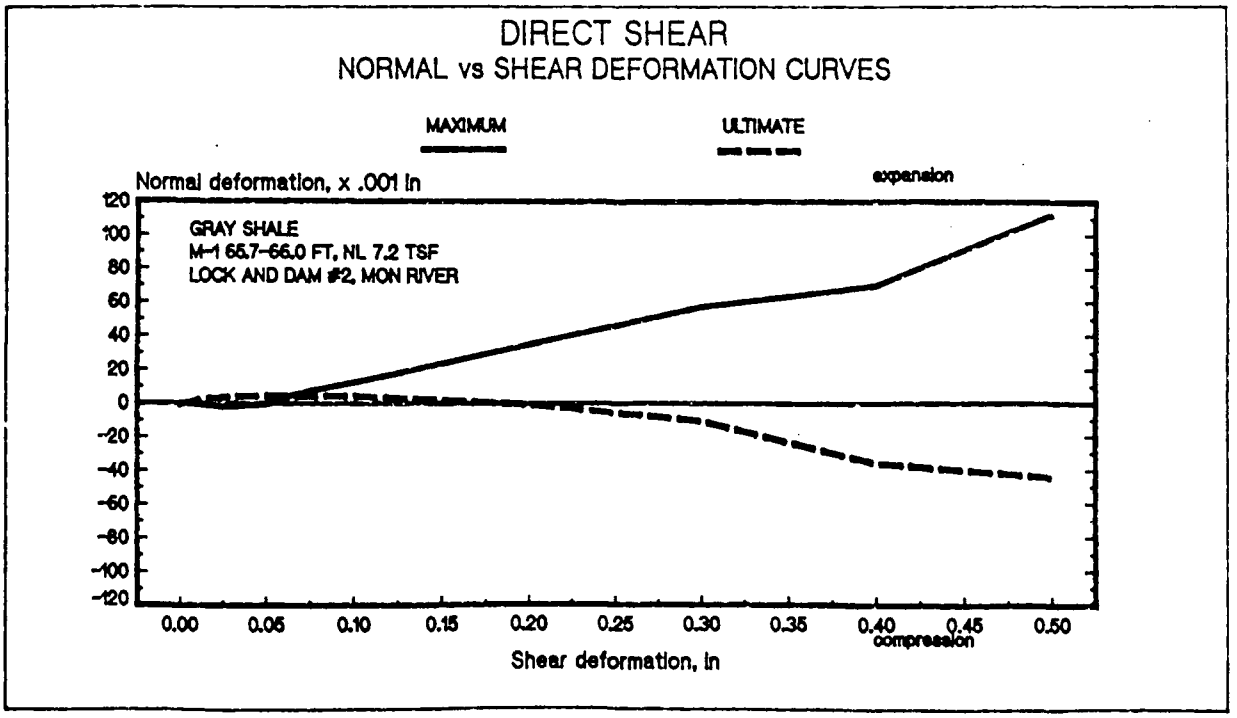

DIRECT SHEAR
STRESS vs DEFORMATION CURVES
MAXIMUM
ULTIMATE
Shear Stress, TSF
40
35
30
25
20
15
10
5
0
GRAY SHALE
M-1 64.45-64.80 FT, NL 3.6 TSF
LOCK AND DAM #2, MON RIVER
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
Shear Deformation, in.

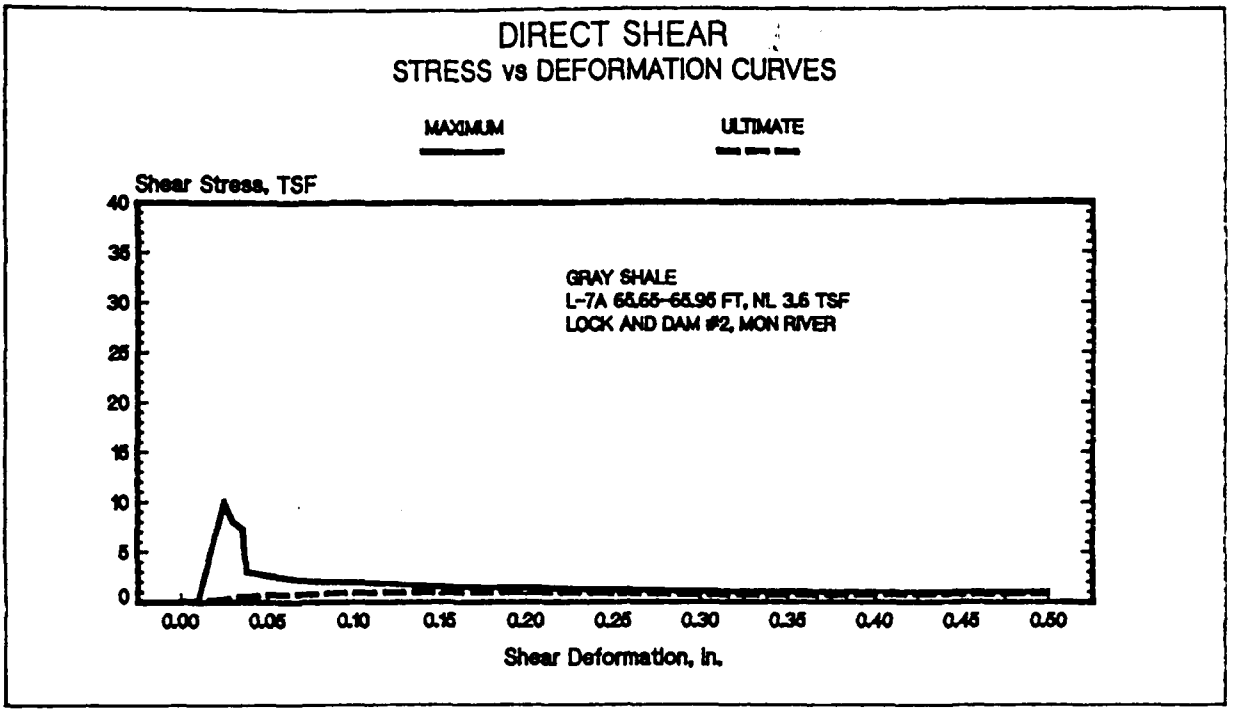

DIRECT SHEAR
NORMAL vs SHEAR DEFORMATION CURVES
MAXIMUM
ULTIMATE
Normal deformation, x .001 in
expansion
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
GRAY SHALE
M-1 64.45-64.80 FT, NL 3.6
LOCK AND DAM #2, MON RIVER
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
compression
Shear deformation, in

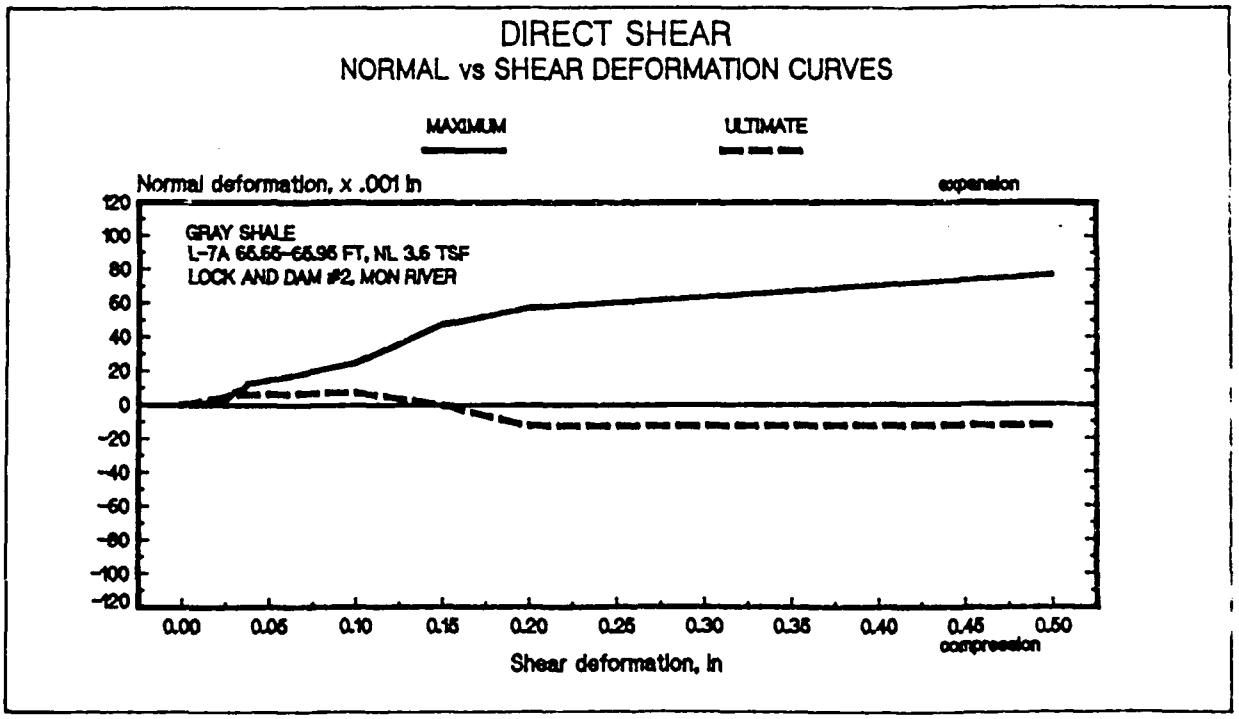

DIRECT SHEAR
STRESS vs DEFORMATION CURVES
MAXIMUM
ULTIMATE
Shear Stress, TSF
40
35
30
25
20
15
10
5
0
GRAY SHALE
M-1 65.45-65.70 FT, NL 3.6 TSF
LOCK AND DAM #2, MON RIVER
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
Shear Deformation, in.


DIRECT SHEAR
NORMAL vs SHEAR DEFORMATION CURVES
MAXIMUM
ULTIMATE
Normal deformation, x .001 in
expansion
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
GRAY SHALE
M-1 65.45-65.70 FT, NL 3.6 TSF
LOCK AND DAM #2, MON RIVER
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
compression
Shear deformation, in

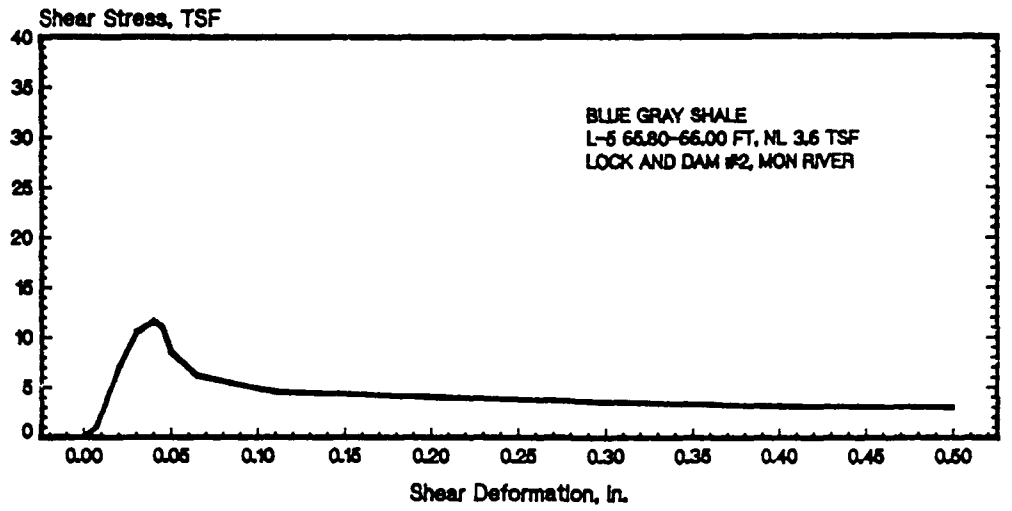

DIRECT SHEAR
STRESS vs DEFORMATION CURVES
MAXIMUM
ULTIMATE
Shear Stress, TSF
40
35
30
25
20
15
10
5
0
GRAY SHALE
M-1 65.70-66.00 FT, NL 7.2 TSF
LOCK AND DAM #2, MON RIVER
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
Shear Deformation, in.


DIRECT SHEAR
NORMAL vs SHEAR DEFORMATION CURVES
MAXIMUM
ULTIMATE
Normal deformation, x .001 in
expansion
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
GRAY SHALE
M-1 65.7-66.0 FT, NL 7.2 TSF
LOCK AND DAM #2, MON RIVER
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
compression
Shear deformation, in

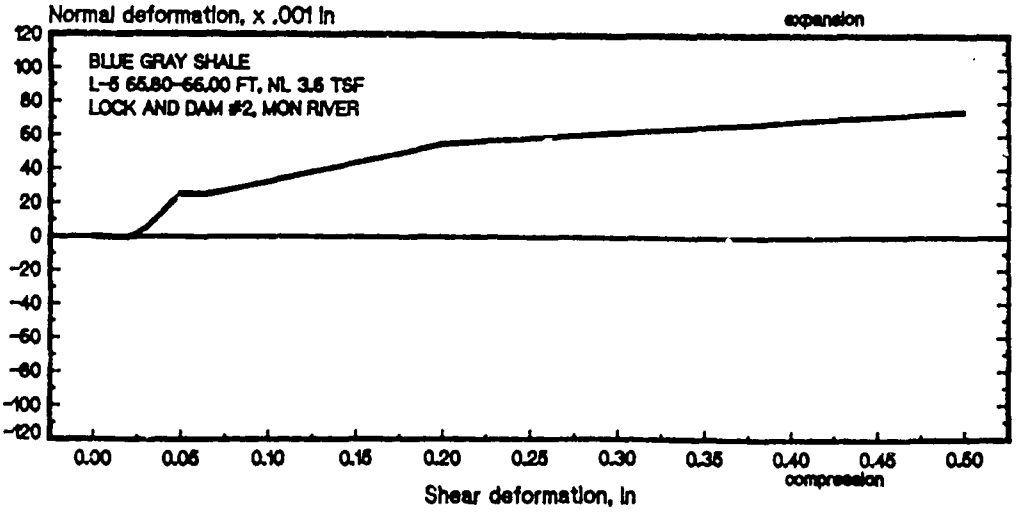

DIRECT SHEAR
STRESS vs DEFORMATION CURVES
MAXIMUM
ULTIMATE
Shear Stress, TSF
40
35
30
25
20
15
10
5
0
GRAY SHALE
L-7A 65.65-65.95 FT, NL 3.6 TSF
LOCK AND DAM #2, MON RIVER
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
Shear Deformation, in.

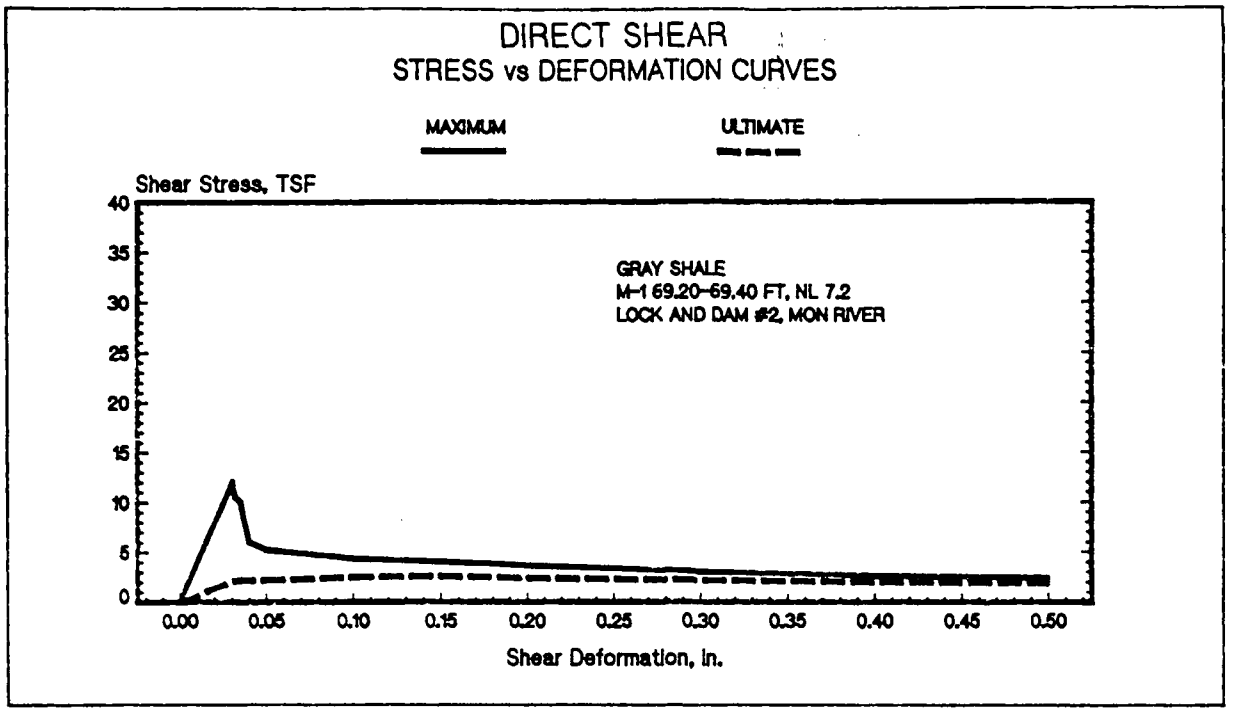

DIRECT SHEAR
NORMAL vs SHEAR DEFORMATION CURVES
MAXIMUM
ULTIMATE
Normal deformation, x .001 in
expansion
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
GRAY SHALE
L-7A 65.65-65.95 FT, NL 3.6 TSF
LOCK AND DAM #2, MON RIVER
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
compression
Shear deformation, in

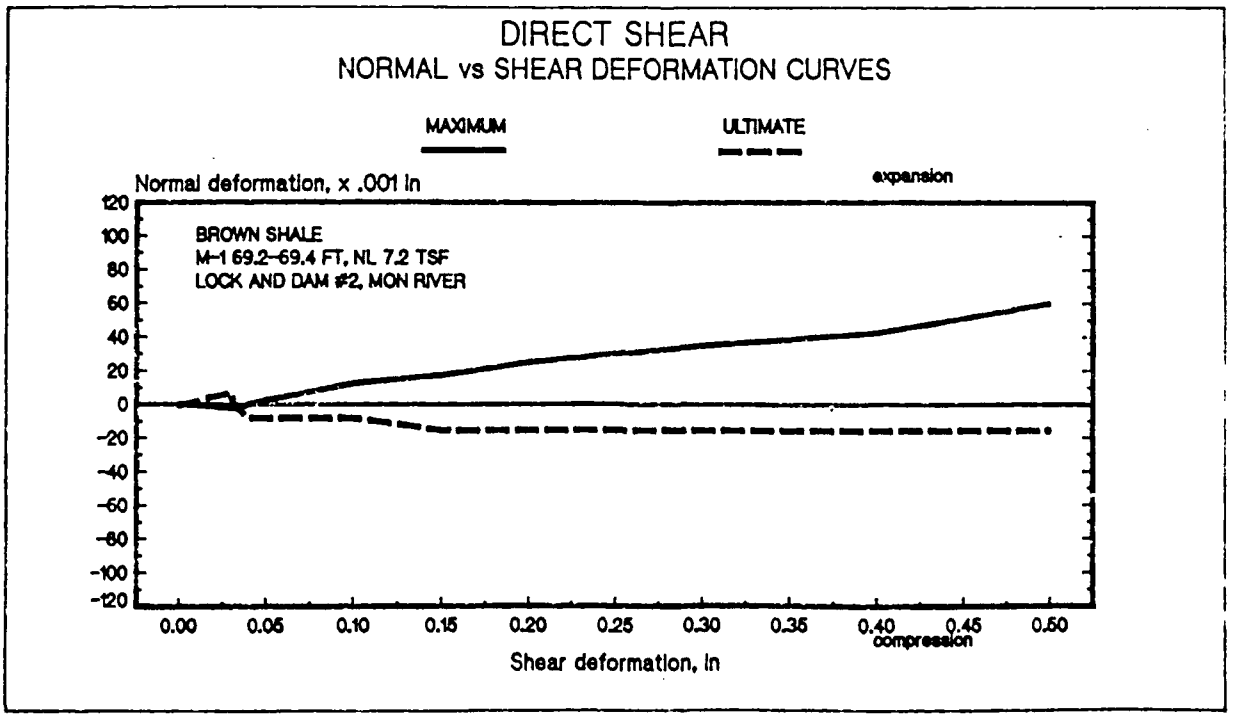
DIRECT SHEAR
STRESS vs DEFORMATION CURVES

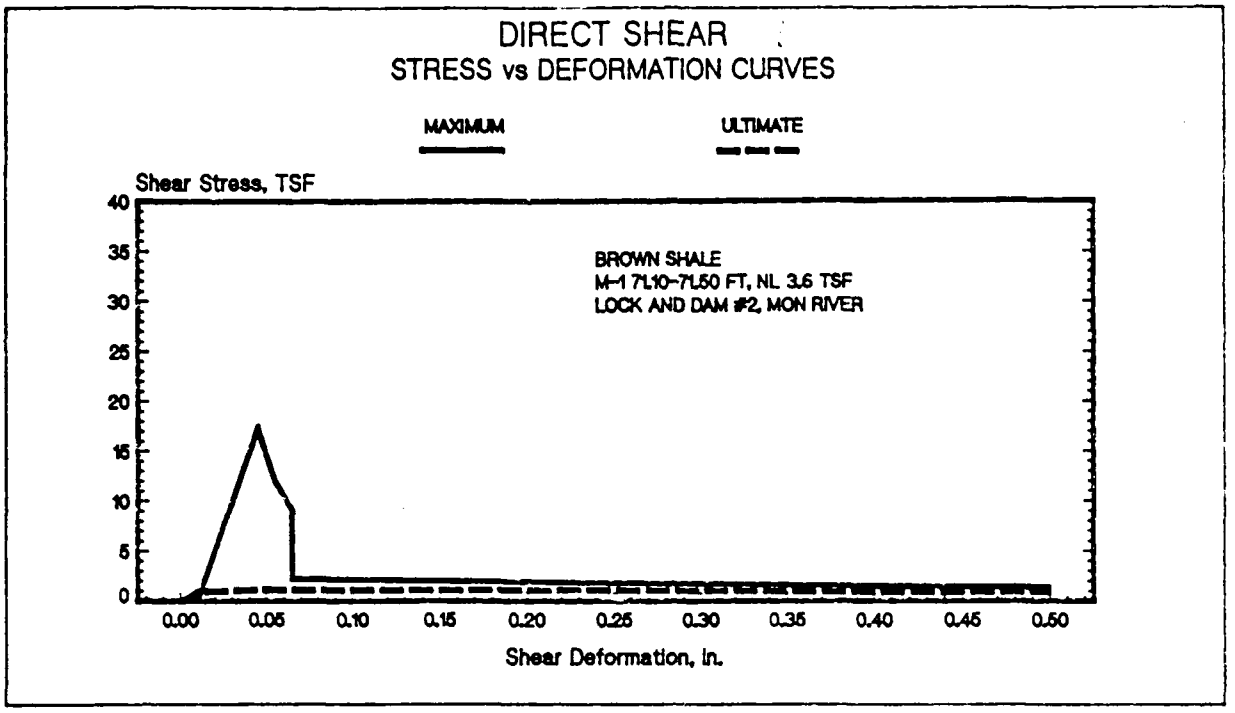


DIRECT SHEAR
NORMAL vs SHEAR DEFORMATION CURVES




DIRECT SHEAR
STRESS vs DEFORMATION CURVES
MAXIMUM
ULTIMATE
Shear Stress, TSF
40
35
30
25
20
15
10
5
0
GRAY SHALE
M-1 69.20-69.40 FT, NL 7.2
LOCK AND DAM #2, MON RIVER
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
Shear Deformation, in.


DIRECT SHEAR
NORMAL vs SHEAR DEFORMATION CURVES
MAXIMUM
ULTIMATE
Normal deformation, x .001 in
expansion
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
BROWN SHALE
M-1 69.2-69.4 FT, NL 7.2 TSF
LOCK AND DAM #2, MON RIVER
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
compression
Shear deformation, in


DIRECT SHEAR
STRESS vs DEFORMATION CURVES
MAXIMUM
ULTIMATE
Shear Stress, TSF
40
35
30
25
20
15
10
5
0
BROWN SHALE
M-1 71.10-71.50 FT, NL 3.6 TSF
LOCK AND DAM #2, MON RIVER
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
Shear Deformation, in.

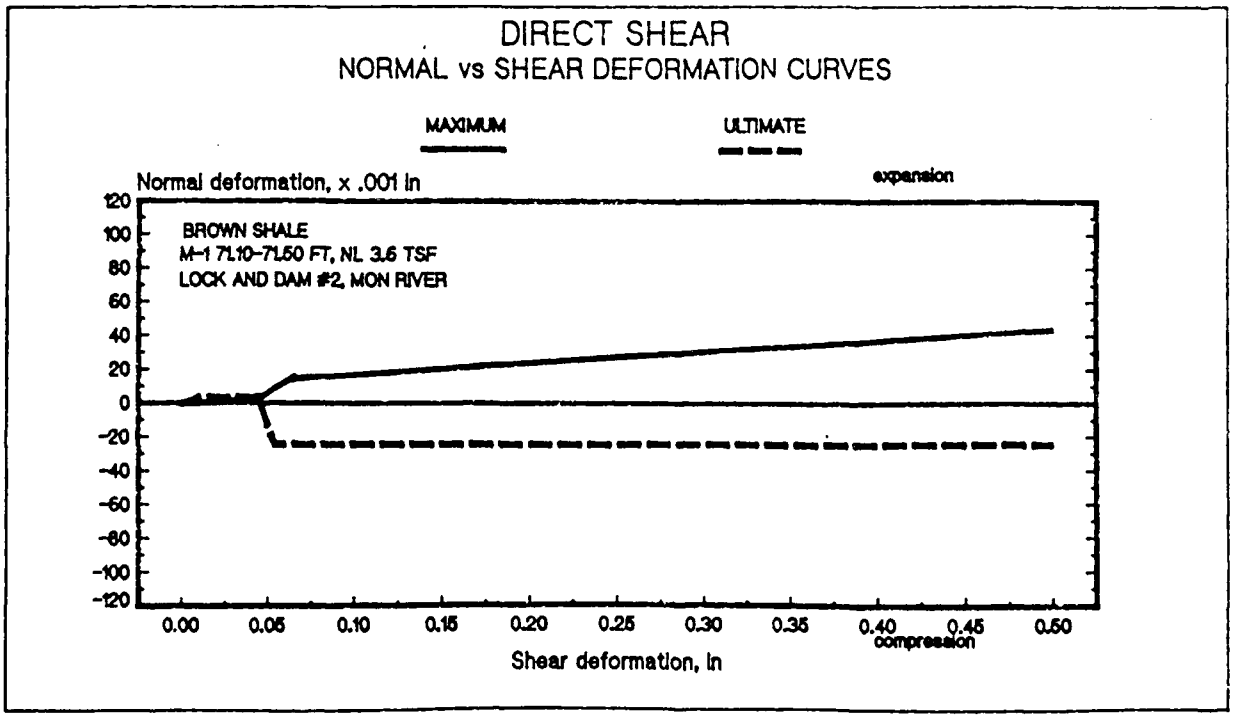
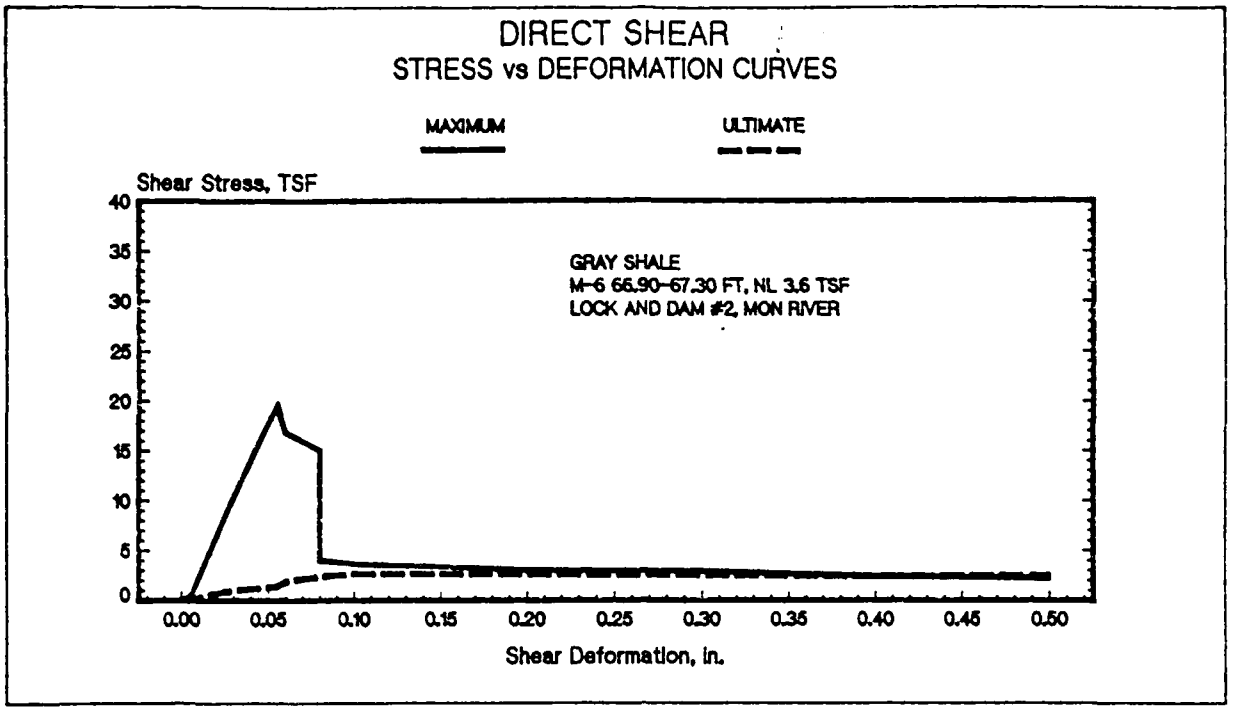
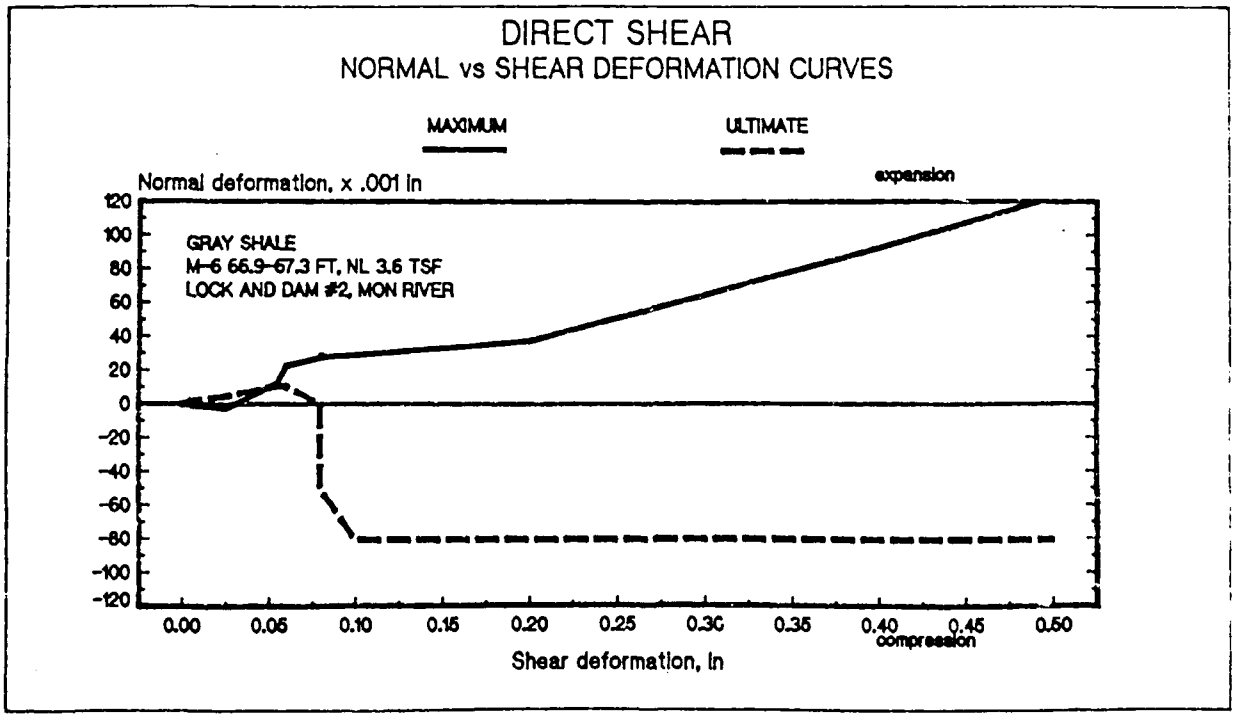
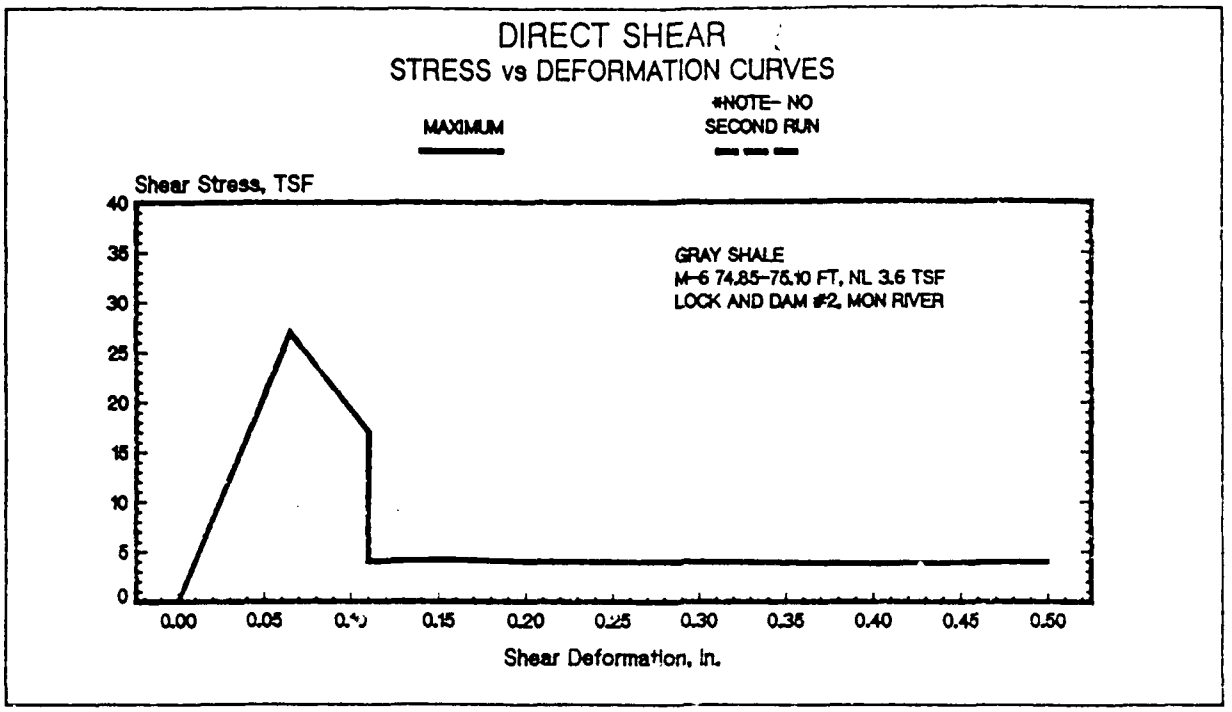
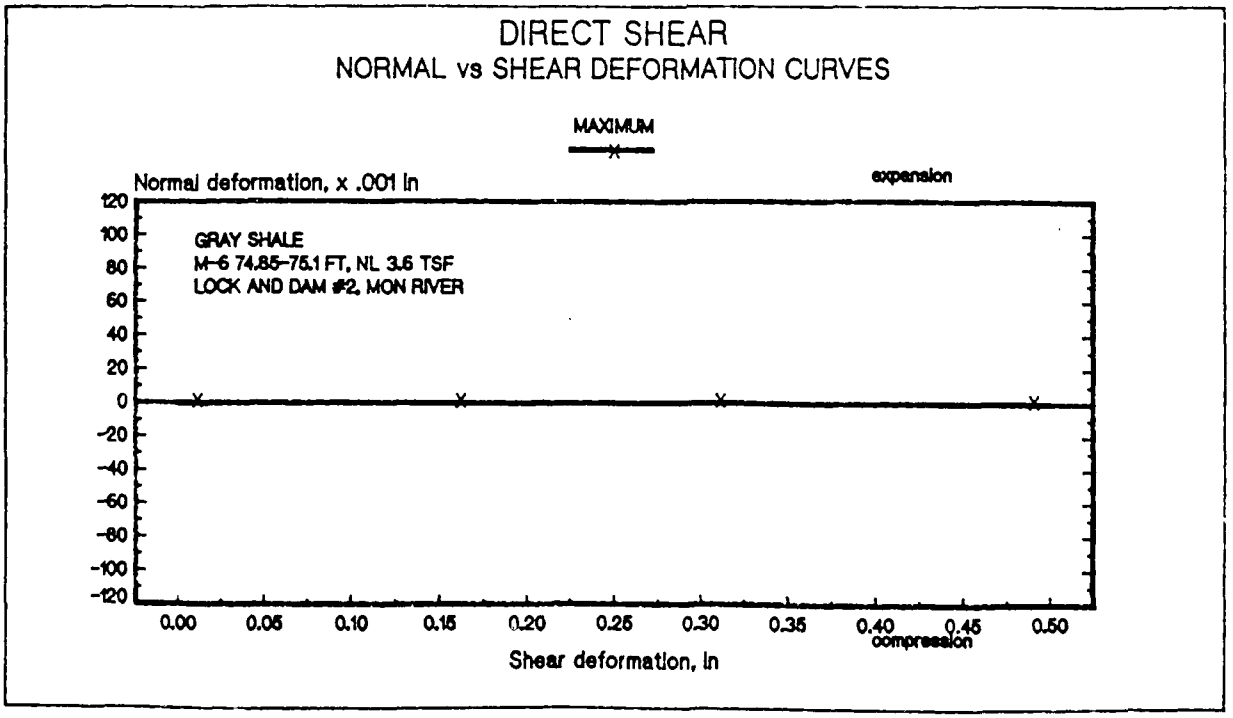

DIRECT SHEAR
NORMAL vs SHEAR DEFORMATION CURVES
MAXIMUM
ULTIMATE
Normal deformation, x .001 in
expansion
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
BROWN SHALE
M-1 71.10-71.50 FT, NL 3.6 TSF
LOCK AND DAM #2, MON RIVER
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
compression
Shear deformation, in

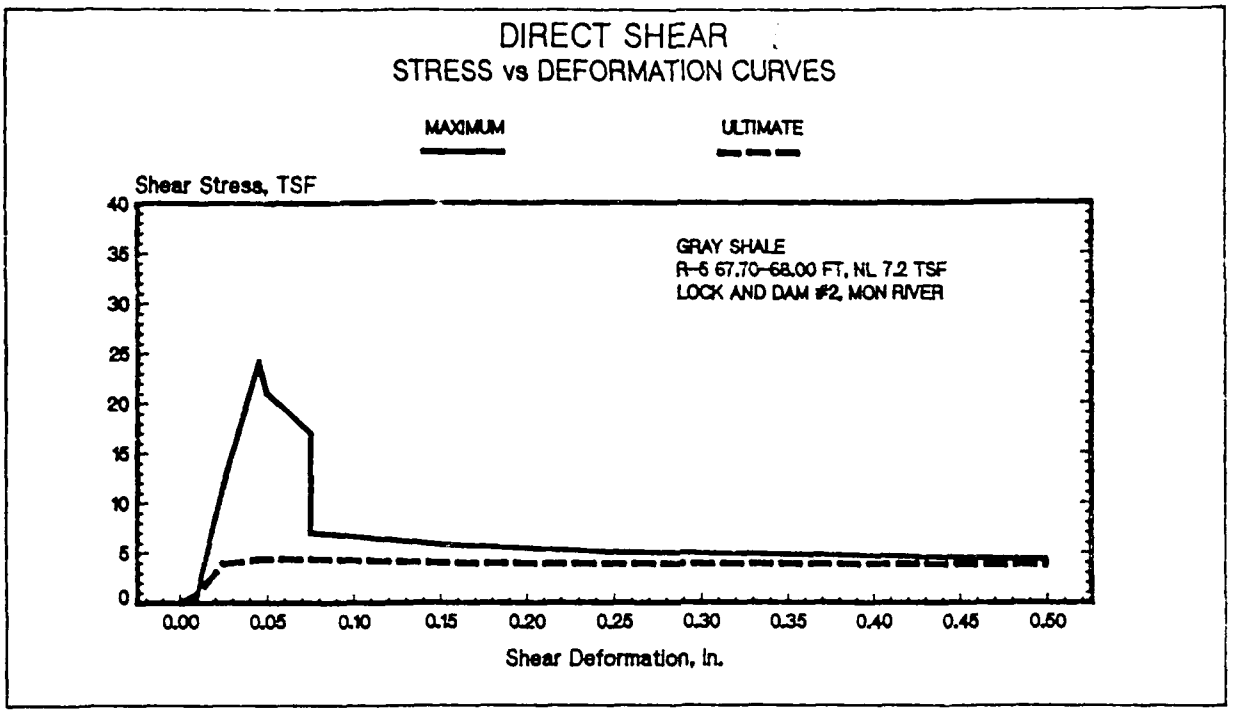
Plate 30

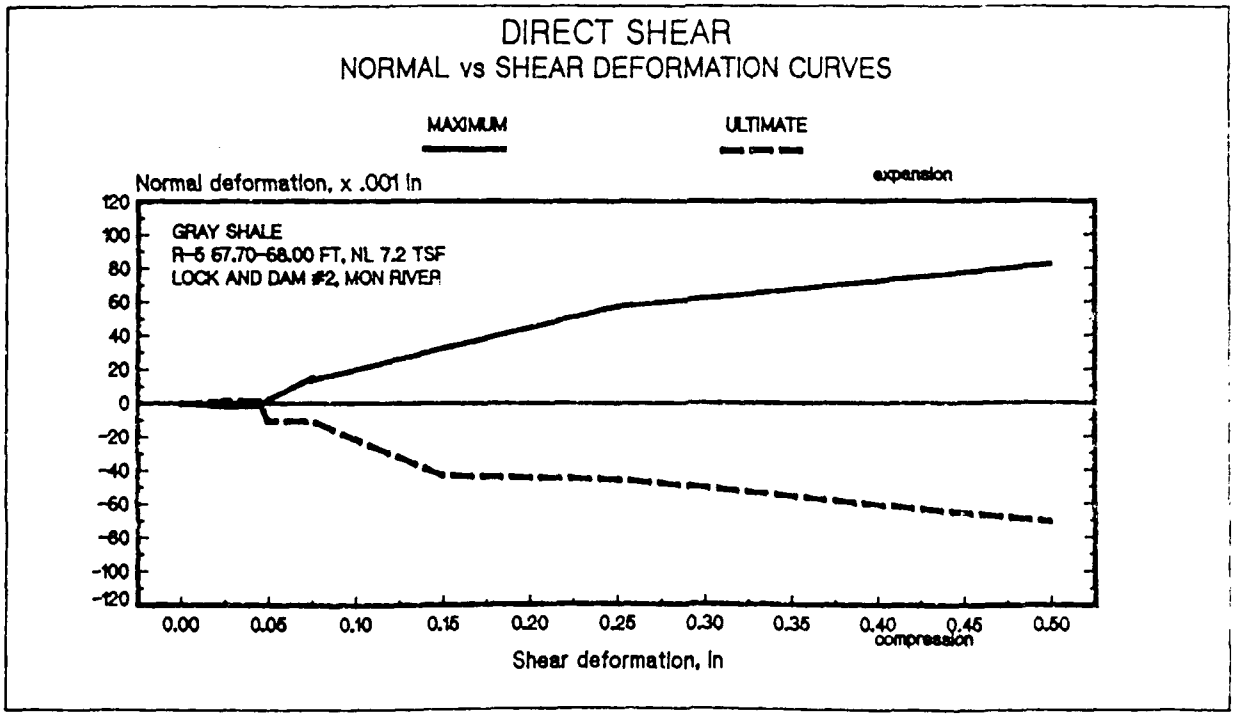

DIRECT SHEAR
STRESS vs DEFORMATION CURVES
MAXIMUM
ULTIMATE
Shear Stress, TSF
40
35
30
25
20
15
10
5
0
GRAY SHALE
M-6 66.90-67.30 FT, NL 3.6 TSF
LOCK AND DAM #2, MON RIVER
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
Shear Deformation, in.

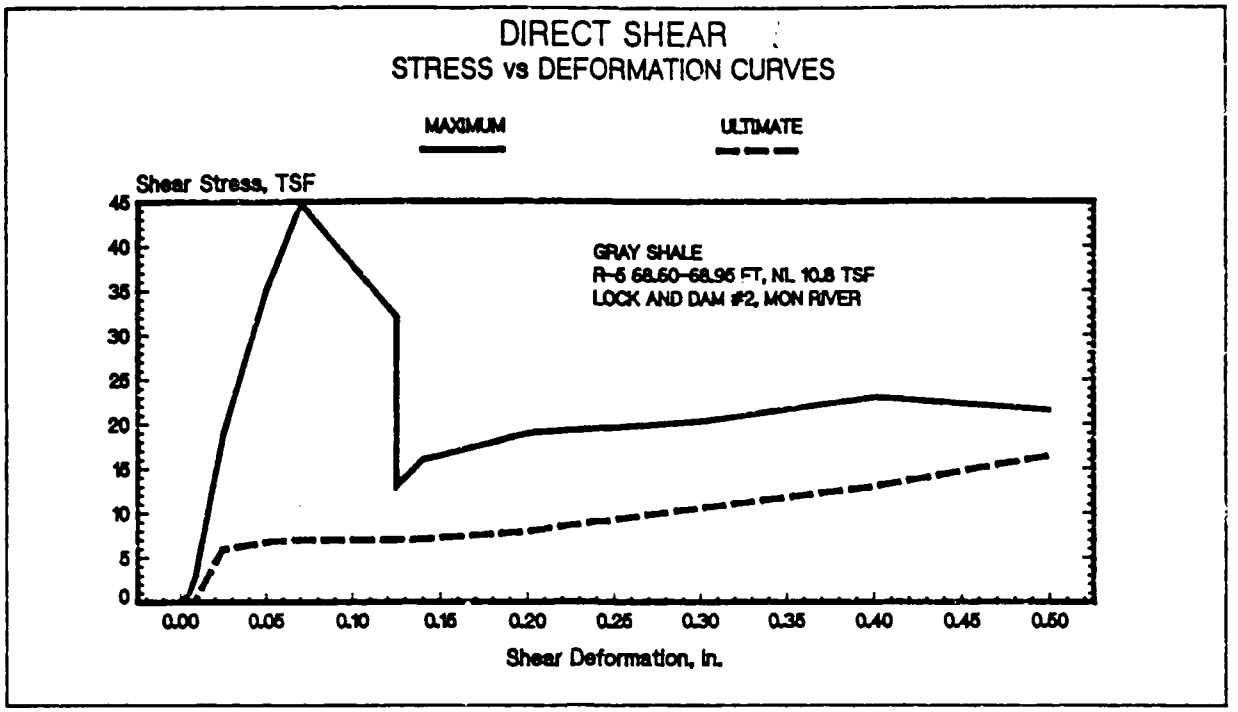

DIRECT SHEAR
NORMAL vs SHEAR DEFORMATION CURVES
MAXIMUM
ULTIMATE
Normal deformation, x .001 in
expansion
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
GRAY SHALE
M-6 66.9-67.3 FT, NL 3.6 TSF
LOCK AND DAM #2, MON RIVER
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
compression
Shear deformation, in

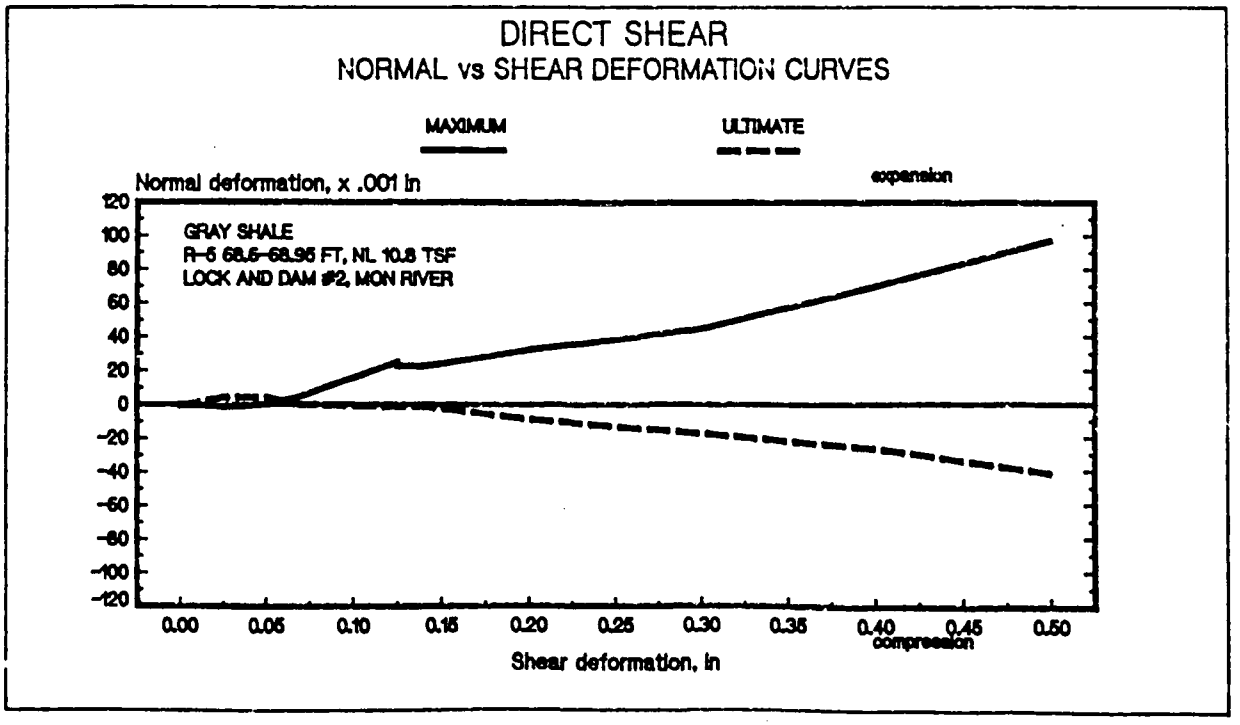

DIRECT SHEAR
STRESS vs DEFORMATION CURVES
MAXIMUM
*NOTE- NO SECOND RUN
Shear Stress, TSF
40
35
30
25
20
15
10
5
0
GRAY SHALE
M-6 74.85-75.10 FT, NL 3.6 TSF
LOCK AND DAM #2, MON RIVER
0.00
0.05
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
Shear Deformation, in.


DIRECT SHEAR
NORMAL vs SHEAR DEFORMATION CURVES
MAXIMUM
Normal deformation, x .001 in
expansion
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
GRAY SHALE
M-6 74.85-75.1 FT, NL 3.6 TSF
LOCK AND DAM #2, MON RIVER
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
compression
Shear deformation, in


DIRECT SHEAR
STRESS vs DEFORMATION CURVES
MAXIMUM
ULTIMATE
Shear Stress, TSF
40
35
30
25
20
15
10
5
0
GRAY SHALE
R-6 67.70-68.00 FT, NL 7.2 TSF
LOCK AND DAM #2, MON RIVER
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
Shear Deformation, in.


DIRECT SHEAR
NORMAL vs SHEAR DEFORMATION CURVES
MAXIMUM
ULTIMATE
Normal deformation, x .001 in
expansion
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
GRAY SHALE
R-6 67.70-68.00 FT, NL 7.2 TSF
LOCK AND DAM #2, MON RIVER
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
compression
Shear deformation, in


DIRECT SHEAR
STRESS vs DEFORMATION CURVES
MAXIMUM
ULTIMATE
Shear Stress, TSF
45
40
35
30
25
20
15
10
5
0
GRAY SHALE
R-5 68.60-68.95 FT, NL 10.8 TSF
LOCK AND DAM #2, MON RIVER
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
Shear Deformation, in.


DIRECT SHEAR
NORMAL vs SHEAR DEFORMATION CURVES
MAXIMUM
ULTIMATE
Normal deformation, x .001 in
expansion
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
GRAY SHALE
R-5 68.6-68.95 FT, NL 10.8 TSF
LOCK AND DAM #2, MON RIVER
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
compression
Shear deformation, in

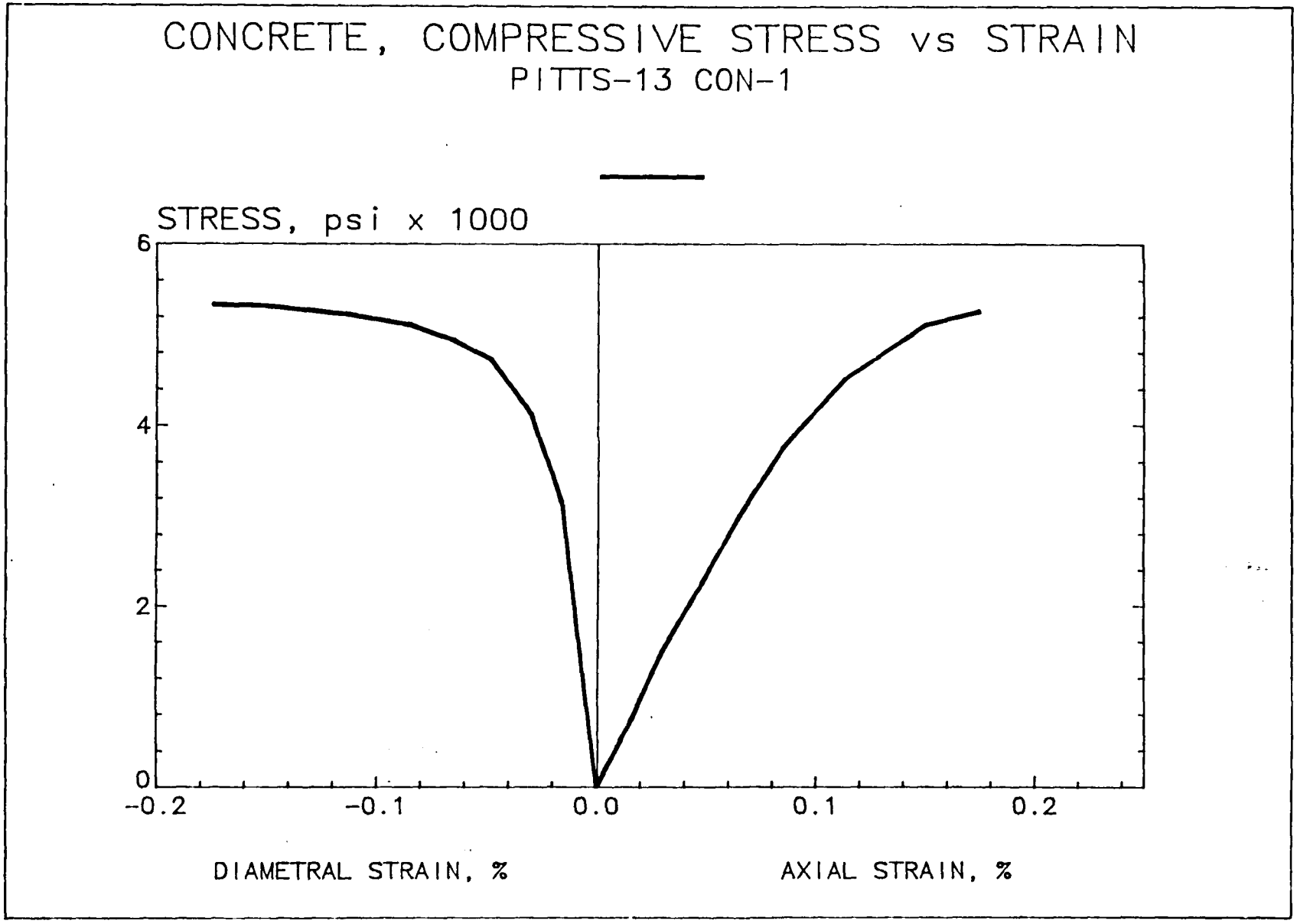

CONCRETE, COMPRESSIVE STRESS vs STRAIN
PITTS-13 CON-1
STRESS, psi x 1000
6
4
2
0
-0.2
-0.1
0.0
0.1
0.2
DIAMETRAL STRAIN, %
AXIAL STRAIN, %

Plate 35

CONCRETE, COMPRESSIVE STRESS vs STRAIN

PITTS-13 CON-29

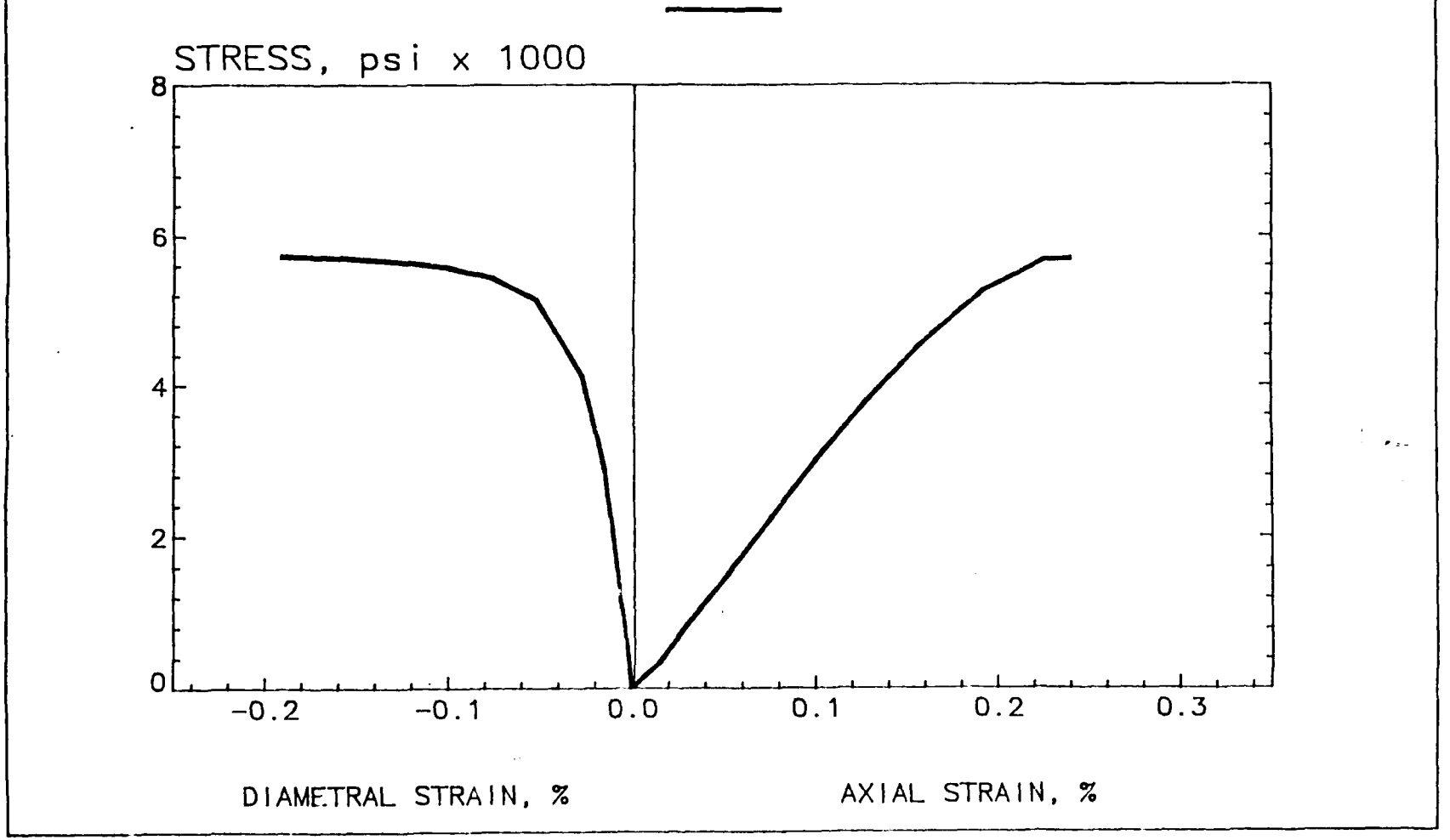


Plate 36

CONCRETE, COMPRESSIVE STRESS vs STRAIN
PITTS-13 CON-51

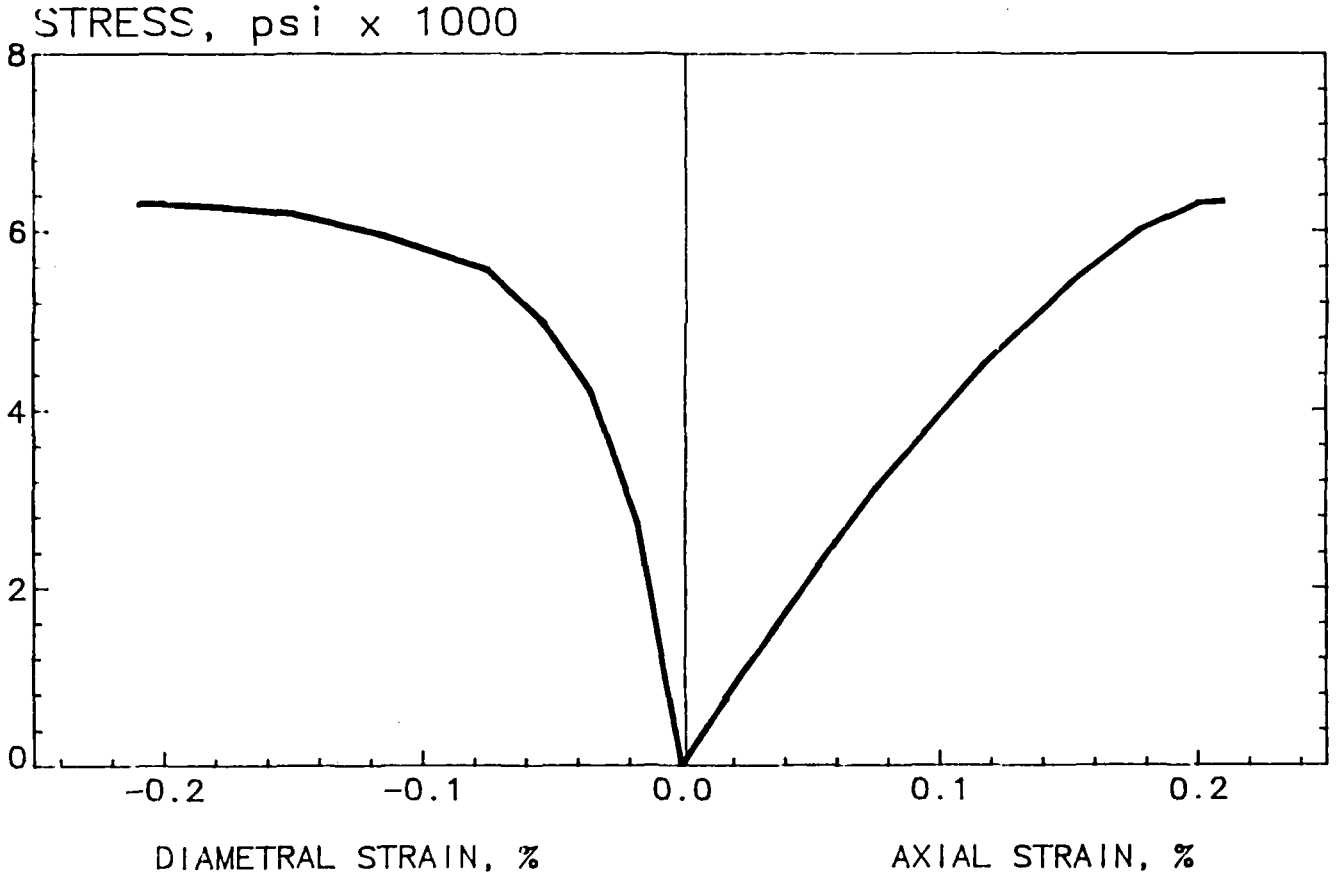


Plate 37

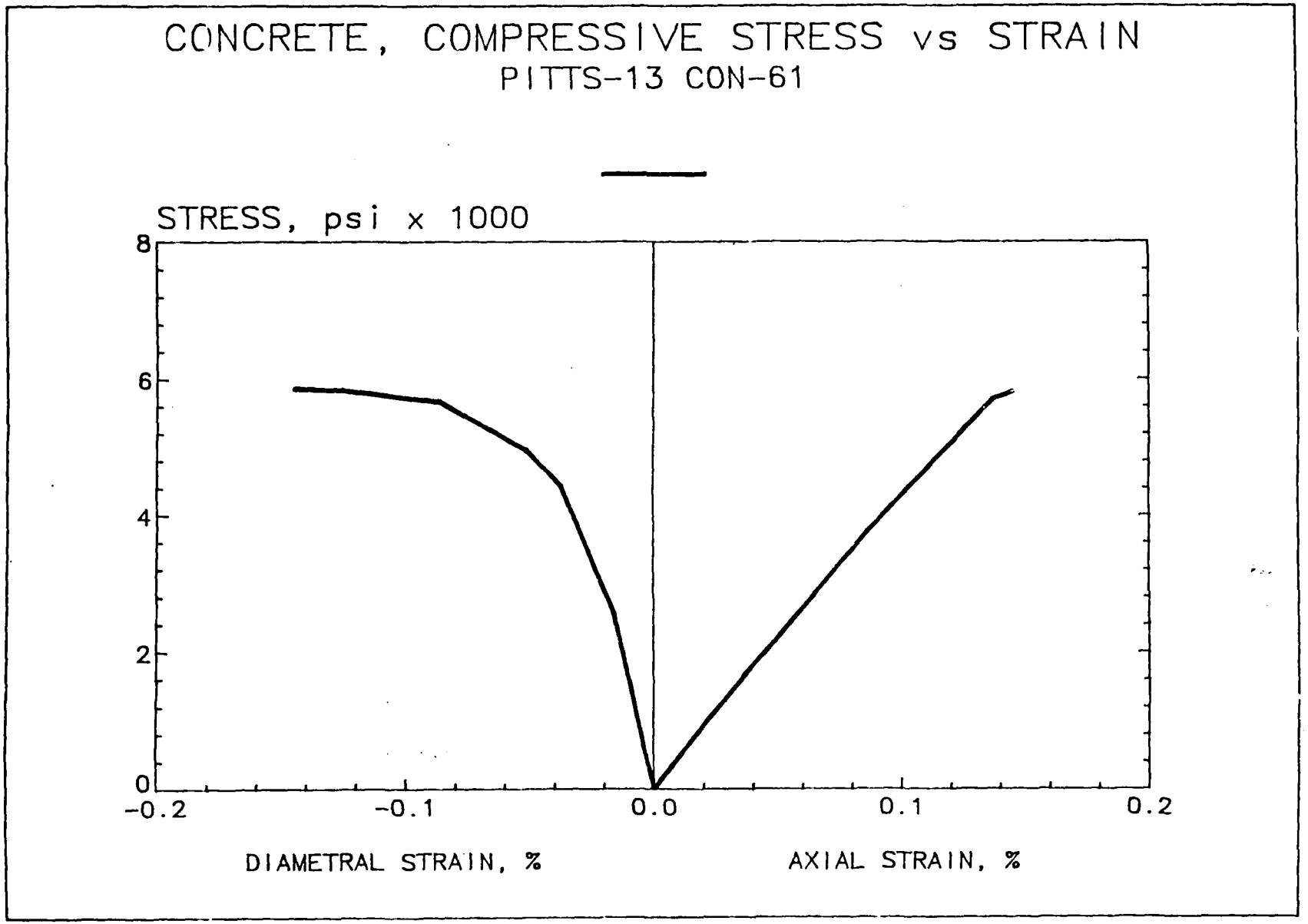

CONCRETE, COMPRESSIVE STRESS vs STRAIN
PITTS-13 CON-61
STRESS, psi x 1000
8
6
4
2
0
-0.2
-0.1
0.0
0.1
0.2
DIAMETRAL STRAIN, %
AXIAL STRAIN, %

Plate 38

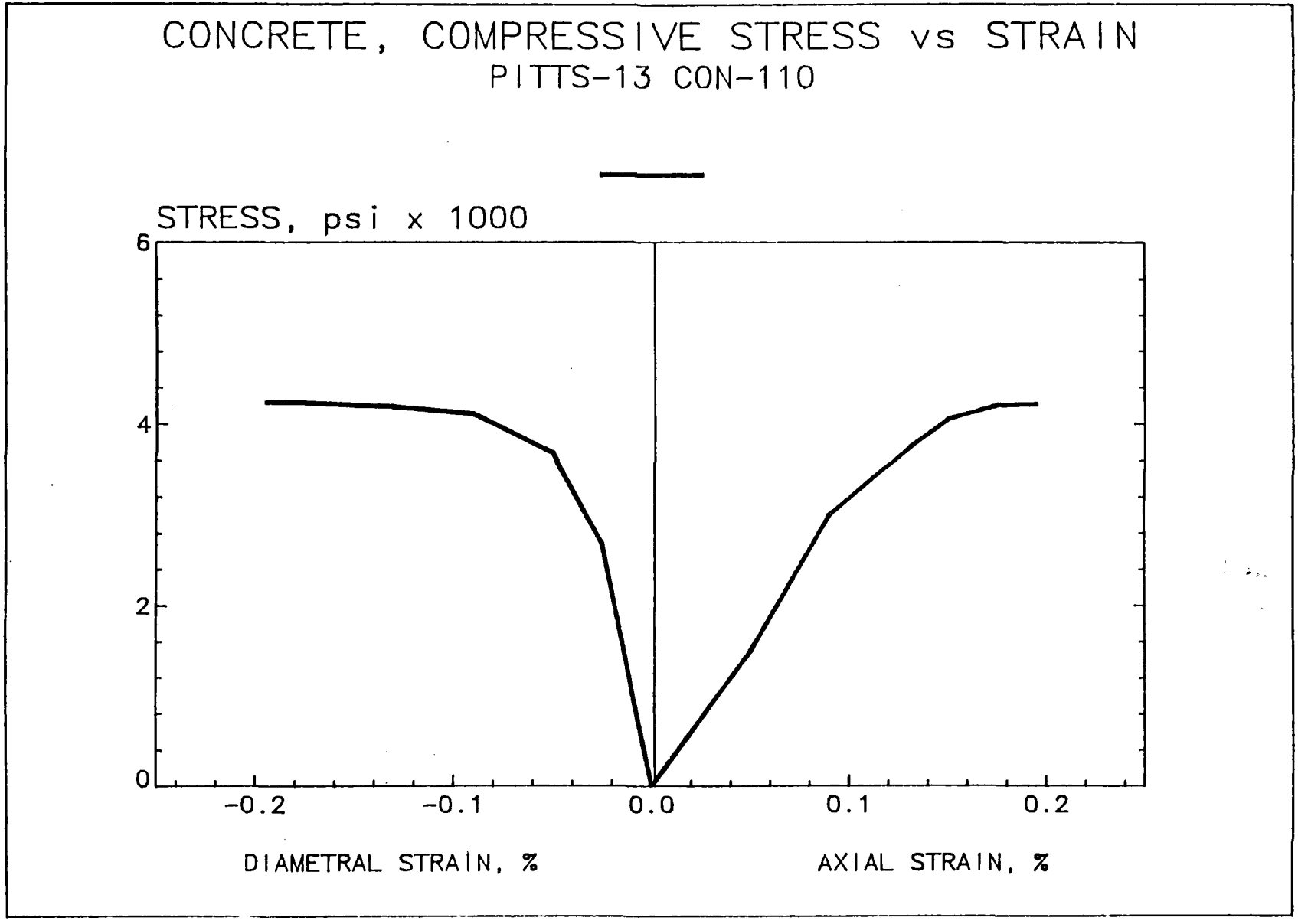

CONCRETE, COMPRESSIVE STRESS vs STRAIN
PITTS-13 CON-110
STRESS, psi x 1000
6
4
2
0
-0.2
-0.1
0.0
0.1
0.2
DIAMETRAL STRAIN, %
AXIAL STRAIN, %

Plate 39

CONCRETE. COMPRESSIVE STRESS vs STRAIN

PITTS-13 CON-112

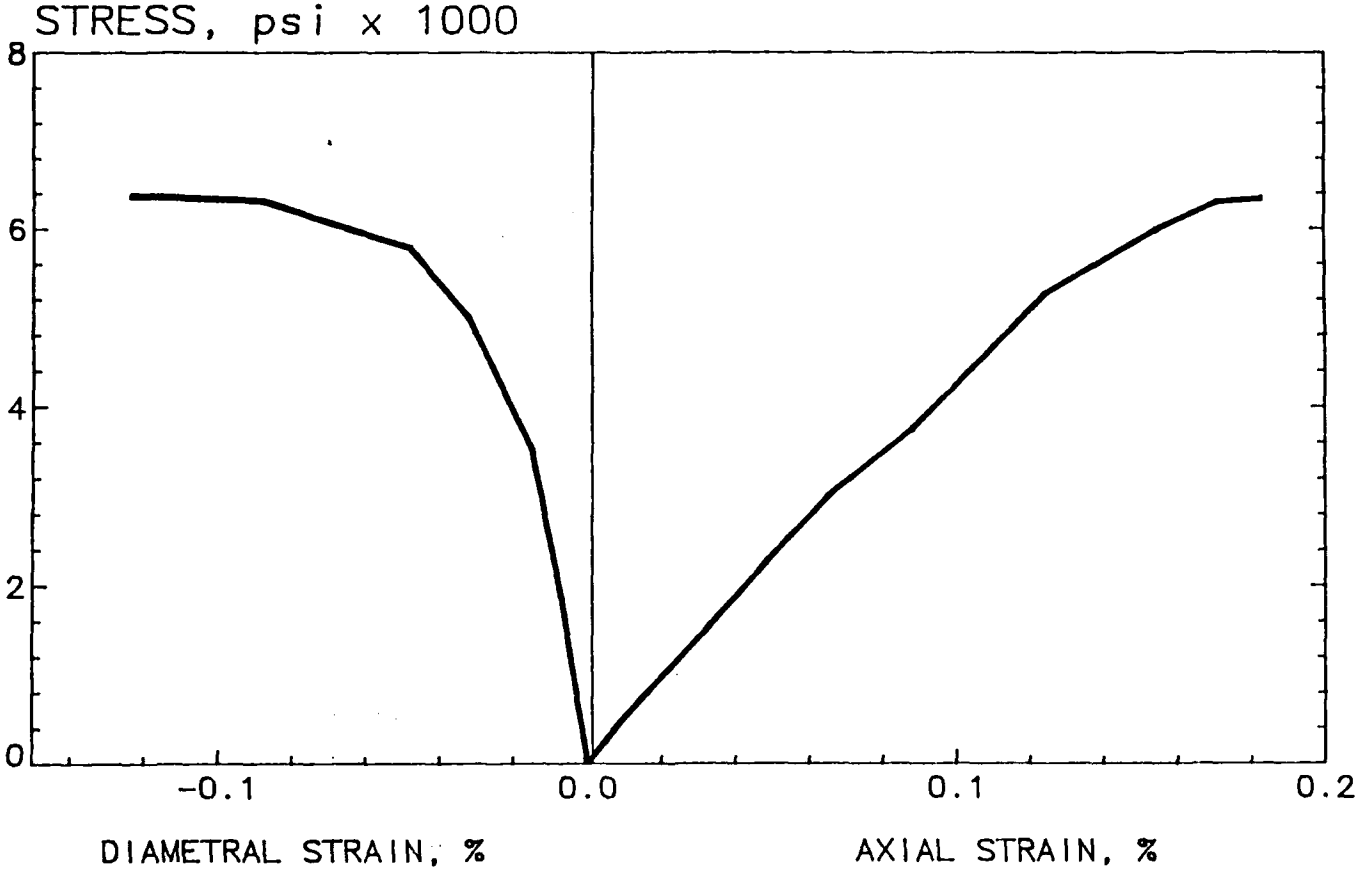
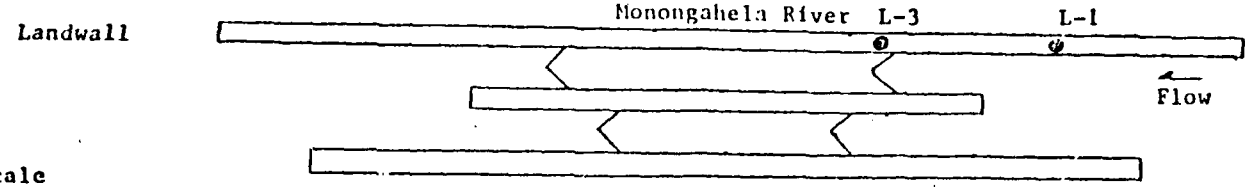


Plate 40

CONCRETE PROPERTIES

Locks and Dam No. 2
Monongahela River



Boring No. BR WES L-1

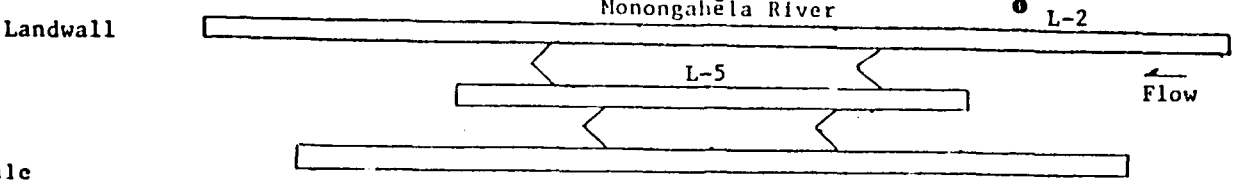
Elev 730.5	Depth ft	Legend	Material	Unit Wt pcf	Vp fps	Comp Strg psi	E x 10^6 psi	ν
	2.0		Surface scaled Concrete good	150.7	16366	5360	4.9	0.21
	4.0		LS agg, max 3", crushed					
	6.0		Air entrained					
	8.0							
	10.0		1" rebar					

Boring No. BR WES L-3

Elev 732.5	Depth	Legend	Material	Unit Wt pcf	Vp fps	Comp Strg psi	E x 10^6 psi	ν
	2.0		Surface scaled Concrete good	151.9	16129	5990		
	4.0		LS agg, max 3", crushed					
	6.0							
	8.0		Air entrained					
	10.0							
	12.0							
	14.0							
	16.0							

Plate 41

CONCRETE PROPERTIES
Locks and Dam No. 2
Monongahela River



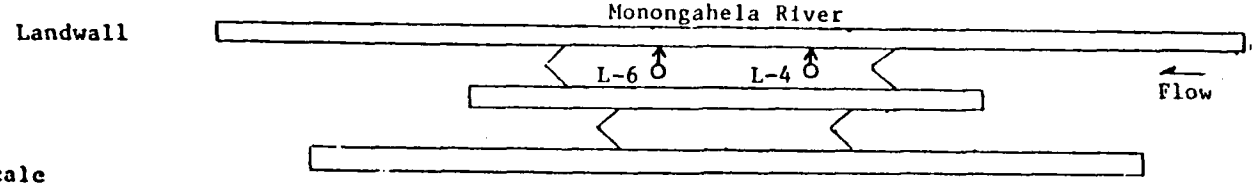
Boring No. BR WES L-2

Elev 727.0	Depth ft	Legend	Material	Unit Wt pcf	Vp fps	Comp Strg psi	E x 10^6 psi	ν
			Mud and Sand					
	1.0		Clayey mud					
	2.0		Slay and SS gravel					
	3.0							
	4.0		Sandy mud with pea gravel					
	5.0							
	6.0		Shale-gray and brown					
	7.0		Soft to mod. hard					
	8.0		Low angle breaks					

Boring No. BR WES L-5

Elev 730.5	Depth	Legend	Material	Unit Wt pcf	Vp fps	Comp Strg psi	E x 10^6 psi	ν
			Concrete, 1:0' LS agg Air Entrained					
	1.0							
	2.0		SS gravel and clay					
	3.0		Slay and Steel 1/2" - 4"					
	4.0		Mud, pea gravel, slag, SS					
	5.0		Shale-blue-gray					
	6.0		Soft to mod. hard					
	7.0		Low angle breaks					

CONCRETE PROPERTIES
Locks and Dam No. 2
Monongahela River



No Scale

Horizontal Boring Locations

Boring No. BR WES L-4

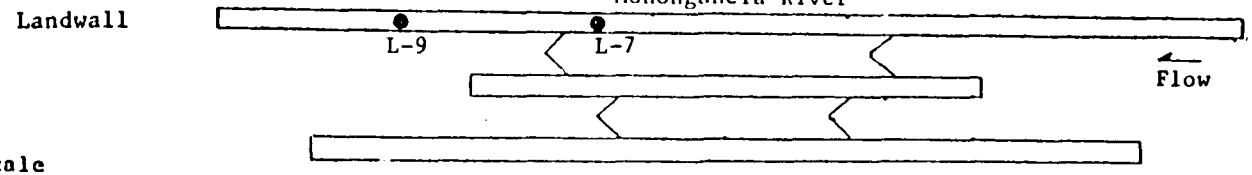
Elev 715.5	Depth ft	Legend	Material	Unit Wt pcf	Vp fps	Comp Strg psi	E x 10^6 psi	ν
	1.0		Surface Weathered Concrete good					
	2.0		LS. agg, max 2", crushed	150.6	16652	4460		
	3.0		Air entrained					

Boring No. BR WES L-6

Elev 726.5	Depth	Legend	Material	Unit Wt pcf	Vp fps	Comp Strg psi	E x 10^6 psi	ν
	1.0		Surface Weathered Concrete good	149.0	15755	6770		
	2.0		LS agg, max 3", crushed					
			Air entrained					

Plate 43

CONCRETE PROPERTIES
Locks and Dam No. 2
Monongahela River



No Scale

Vertical Boring Locations

Boring No. BR WES L-7

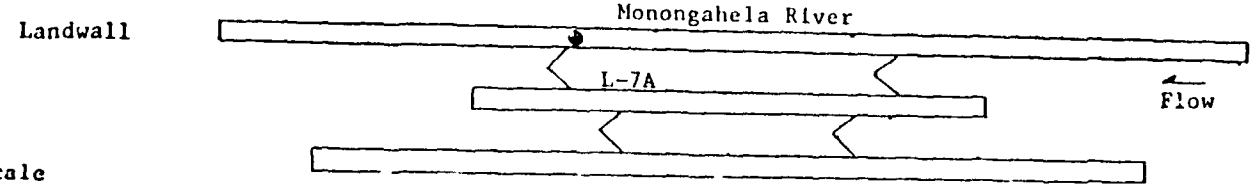
Elev 730.5	Depth ft	Legend	Material	Unit Wt pcf	Vp fps	Comp Strg psi	E x 10^6 psi	ν
	1.0		Surface Scaled Concrete good					
	2.0		LS agg, max 3", crushed					
	3.0		Air entrained					
	4.0							
	5.0		5" pipe					
	6.0							

Boring No. BR WES L-9

Elev 730.5	Depth	Legend	Material	Unit Wt pcf	Vp fps	Comp Strg psi	E x 10^6 psi	ν
	2.0		Surface Scaled Concrete good					
	4.0		LS agg, max 3", crushed					
	6.0		Vert. Crack to 2.8'					
	8.0							
	10.0							

Plate 44

CONCRETE PROPERTIES
Locks and Dam No. 2
Monongahela River



No Scale

Vertical Boring Locations

Boring No.

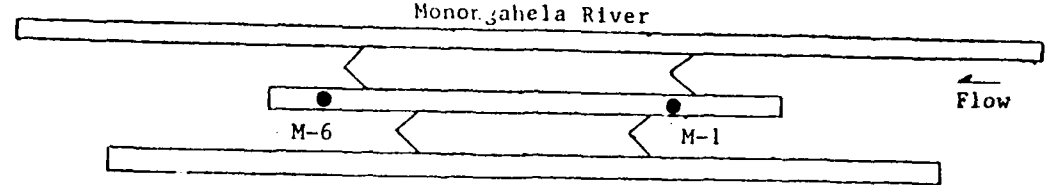
Elev 730.5	Depth ft	Leg-end	Material	Unit Wt pcf	Vp fps	Comp Strg psi	E x 10^6 psi	ν
	15.0		Surface scaled Concrete good					
	30.0		LS agg, max 3", crushed changes to Siliceous agg at 39.5'	146.4	13912	5790	3.0	0.16
	45.0							
	60.0		Air entrained					
	75.0		Shale-gray and red					
	90.0		Soft to mod. hard					
	105.0		Thin, flat, bedding					
	120.0							

Boring No.

Elev 732.5	Depth	Leg-end	Material	Unit Wt pcf	Vp fps	Comp Strg psi	E x 10^6 psi	ν

Plate 45

CONCRETE PROPERTIES
Locks and Dam No. 2
Monongahela River



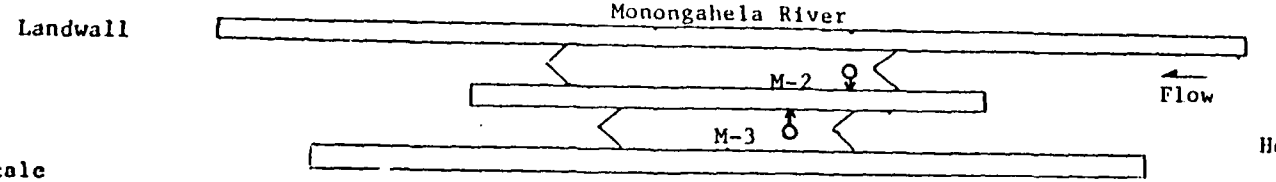
Boring No. BR WES M-1

Elev	Depth ft	Legend	Material	Unit Wt pcf	Vp fps	Comp Strg psi	E x 10^6 psi	ν
				149.0	15349	7840		
	15.0		Concrete good					
	30.0		LS and Siliceous agg, max 3"	147.4	14875	6480	4.2	0.26
	45.0		Air entrained					
	60.0		Shale-gray and brown					
	75.0		Soft to mod. hard					
	90.0							

Boring No. BR WES M-6

Elev	Depth	Legend	Material	Unit Wt pcf	Vp fps	Comp Strg psi	E x 10^6 psi	ν
				145.6	15105	7130		
	15.0		Concrete good					
	30.0		LS agg, max 3"					
	45.0		Construction joints	145.2	14705	6950		
	60.0		Air entrained					
	75.0		Shale-gray mod. hard silty	145.1	14309	7810		
	90.0							

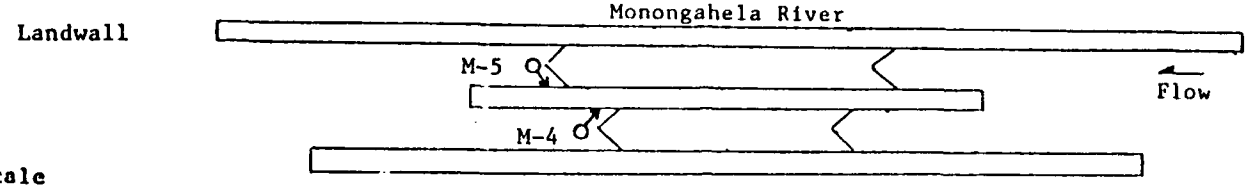
CONCRETE PROPERTIES
Locks and Dam No. 2
Monongahela River



Boring No. BR WES M-2									Boring No. BR WES M-3								
Elev 717.1	Depth ft	Leg-end	Material	Unit Wt pcf	Vp fps	Comp Strg psi	E x 10^6 psi	ν	Elev 716.3	Depth	Leg-end	Material	Unit Wt pcf	Vp fps	Comp Strg psi	E x 10^6 psi	ν
	1.0		Surface Weathered Concrete good							1.0		Surface Weathered Concrete good	145.2	14925	6020	4.4	0.52
	2.0		LS and Siliceous agg, max 4"							2.0		LS and Siliceous agg, max 3"					
	3.0		Air entrained							3.0		Air entrained					

Plate 47

CONCRETE PROPERTIES
Locks and Dam No. 2
Monongahela River



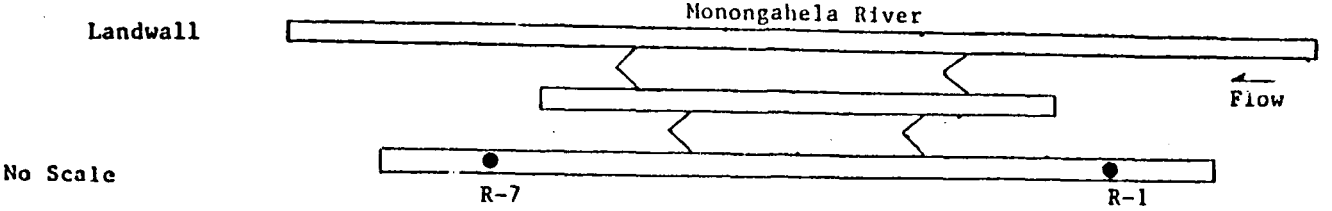
Boring No. BR WES M-4

Elev 725.3	Depth ft	Leg-end	Material	Unit Wt pcf	Vp fps	Comp Strg psi	E x 10^6 psi	ν
	1.0		Surface scaled Concrete good	147.8	15487	6440		
	2.0		LS and siliceous agg, max 4"					
	3.0		Air entrained					

Boring No. BR WES M-5

Elev 723.9	Depth	Leg-end	Material	Unit Wt pcf	Vp fps	Comp Strg psi	E x 10^6 psi	ν
	1.0		Surface scaled Concrete good	146.7	15282	6560		
	2.0		LS and siliceous agg, max 3"					
	3.0		Air entrained					

CONCRETE PROPERTIES
Locks and Dam No. 2
Monongahela River



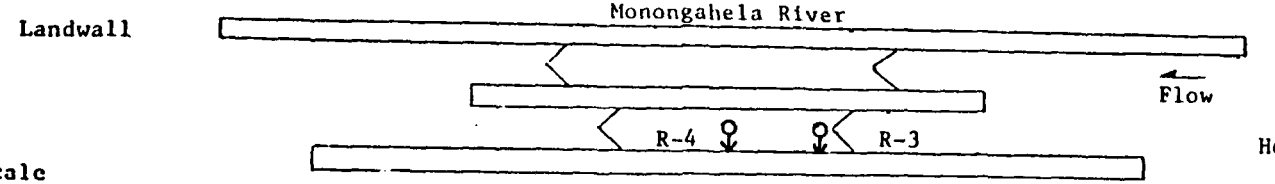
Boring No. BR WES R-1

Elev	Depth ft	Legend	Material	Unit Wt pcf	Vp fps	Comp Strg psi	E x 10^6 psi	ν
			Surface intact Concrete good	143.5	13486	4480	2.9	0.25
	1.0		Siliceous agg, max 1½"					
			Air entrained					
	2.0							

Boring No. BR WES R-7

Elev	Depth	Legend	Material	Unit Wt pcf	Vp fps	Comp Strg psi	E x 10^6 psi	ν
			Surface intact Concrete good					
	1.0		Siliceous agg, max 1½"					
			Air entrained					
	2.0		Rebar at 1.1'					
	3.0							

CONCRETE PROPERTIES
Locks and Dam No. 2
Monongahela River



Boring No. BR WES R-3

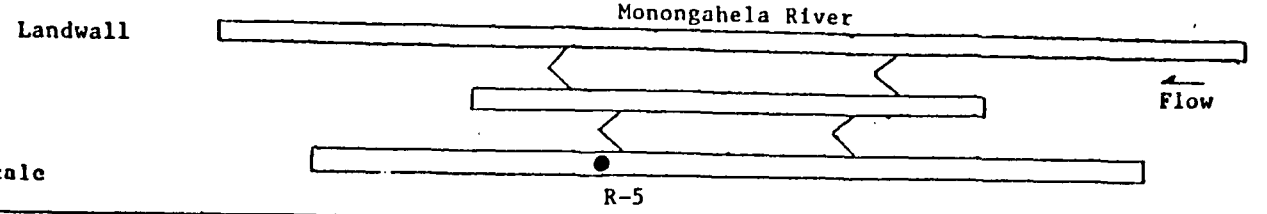
Elev 725.3	Depth ft	Leg-end	Material	Unit Wt pcf	Vp fps	Comp Strg psi	E x 10^6 psi	ν
	1.0		Surface weathered Concrete good	148.3	15487	6830	4.5	0.24
	2.0		LS and siliceous agg, max 3" Air entrained					
	3.0							

Boring No. BR WES R-4

Elev 715.0	Depth	Leg-end	Material	Unit Wt pcf	Vp fps	Comp Strg psi	E x 10^6 psi	ν
	1.0		Surface weathered Concrete good	147.5	15994	6550		
	2.0		LS and siliceous agg, max 3" Air entrained					
	3.0							

Plate 50

CONCRETE PROPERTIES
Locks and Dam No. 2
Monongahela River



Boring No.

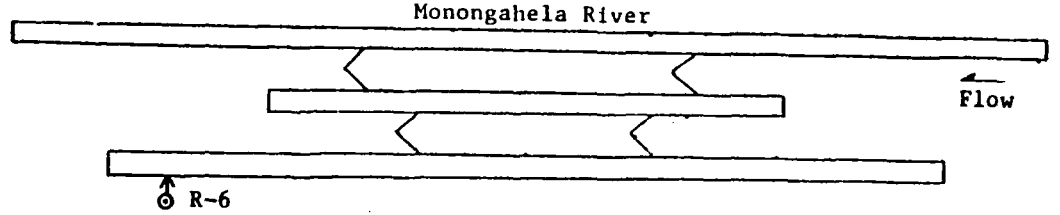
Elev 730.5	Depth ft	Leg-end	Material	Unit Wt pcf	Vp fps	Comp Strg psi	E x 10^6 psi	ν
	15.0		Concrete good Siliceous agg, max 3"	144.1	14492	5890		
	30.0		Air entrained	146.7	15755	6400		
	45.0		Rebar in 6 places					
	60.0			142.4	13801	4500		
	75.0		Shale-gray mod. hard silty					
	90.0							

Boring No.

Elev	Depth	Leg-end	Material	Unit Wt pcf	Vp fps	Comp Strg psi	E x 10^6 psi	ν

Plate 51

CONCRETE PROPERTIES
Locks and Dam No. 2
Monongahela River



No Scale

Inclined Boring Locations

Boring No. BR WES R-6

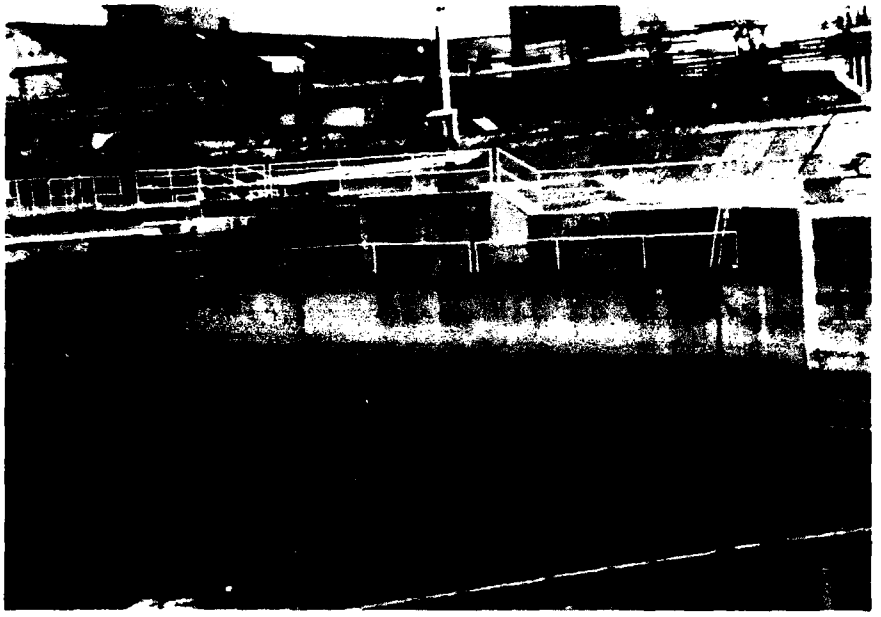
Elev	Depth ft	Leg-end	Material	Unit Wt pcf	Vp fps	Comp Strg psi	E x 10^6 psi	ν
	1.0 2.0 3.0		Surface scaled LS and siliceous agg, max 3" Air entrained					

Boring No.

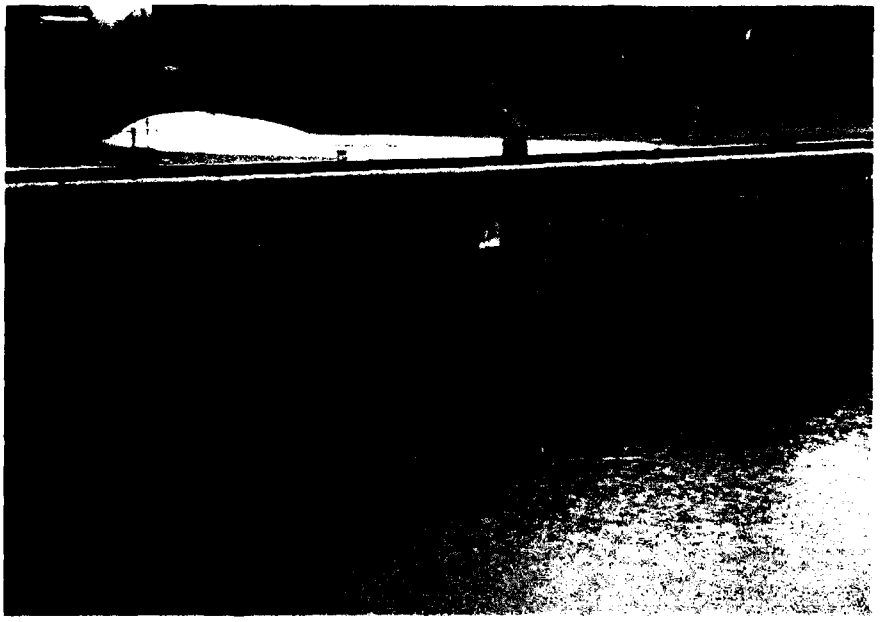
Elev	Depth	Leg-end	Material	Unit Wt pcf	Vp fps	Comp Strg psi	E x 10^6 psi	ν

Plate 52

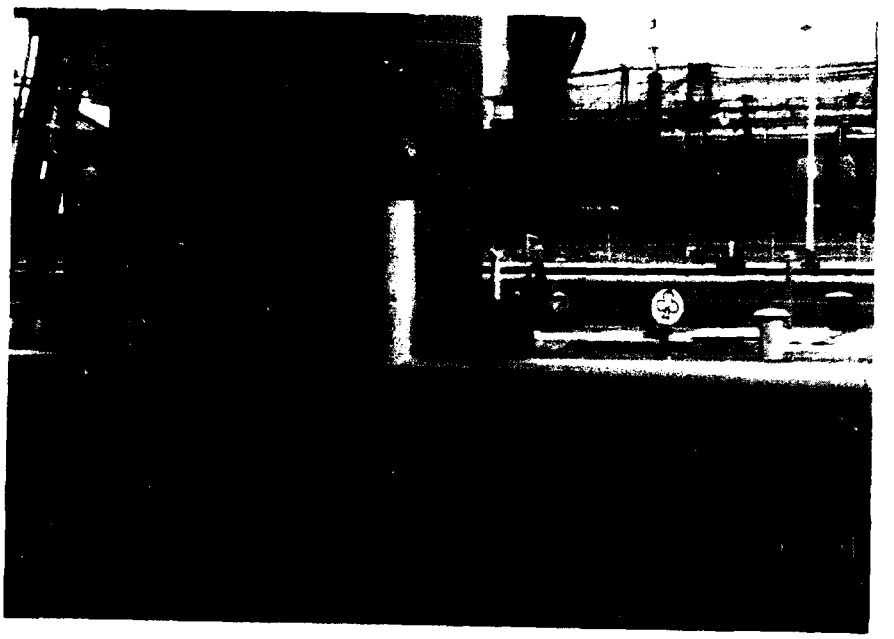
APPENDIX A: PHOTOGRAPHS TAKEN DURING PRELIMINARY STUDY



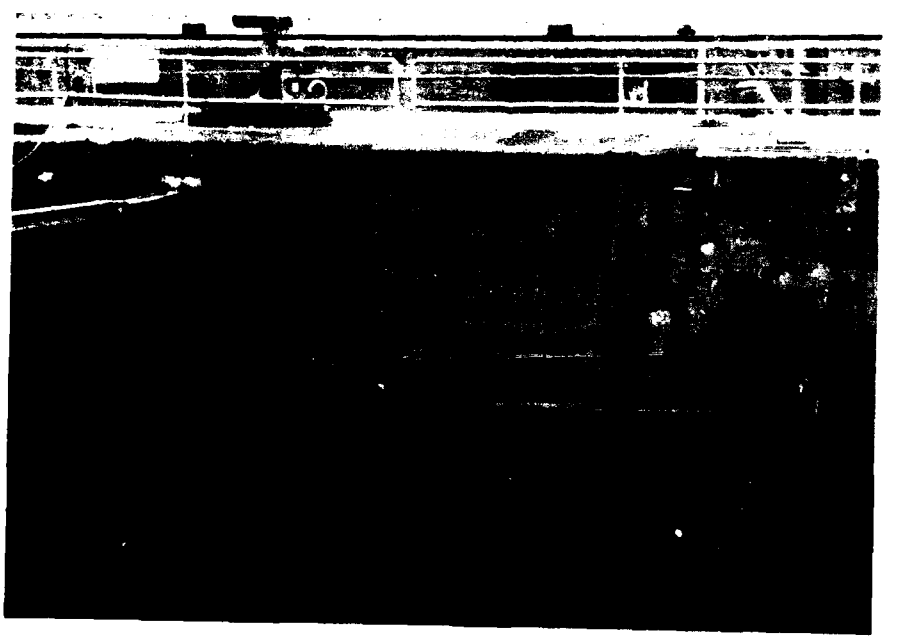
Photograph A1. Land wall lower gate recess



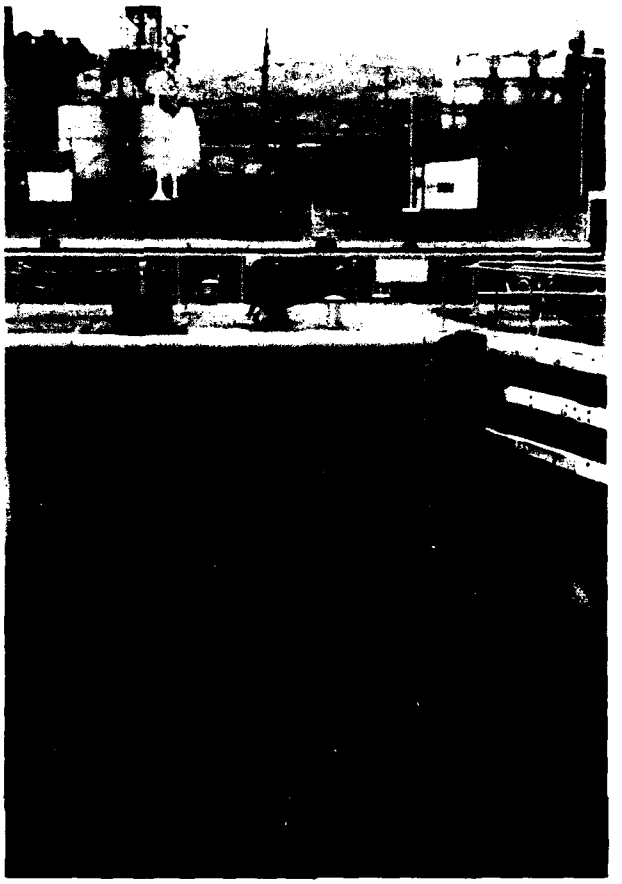
Photograph A2. Land wall lock chamber of large lock



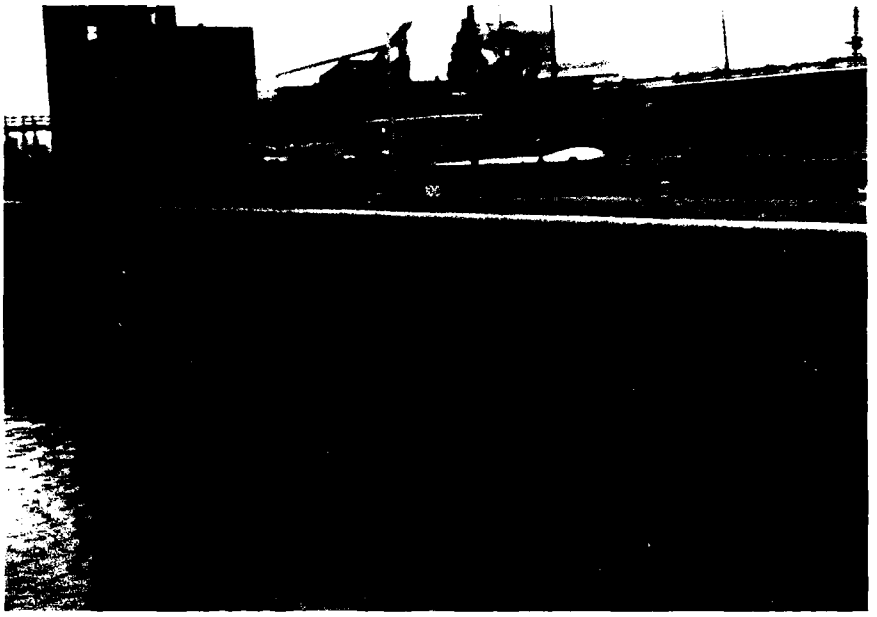
Photograph A3. River face middle wall at monolith M-5



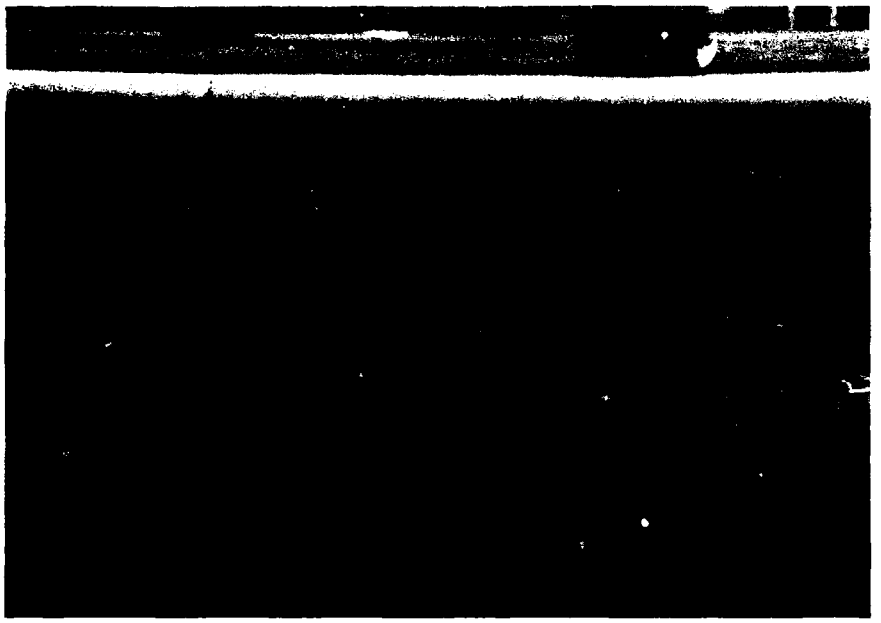
Photograph A4. Gate recess river face middle wall of upper gate in small chamber



Photograph A5. Downstream of upper gate middle wall in small lock chamber

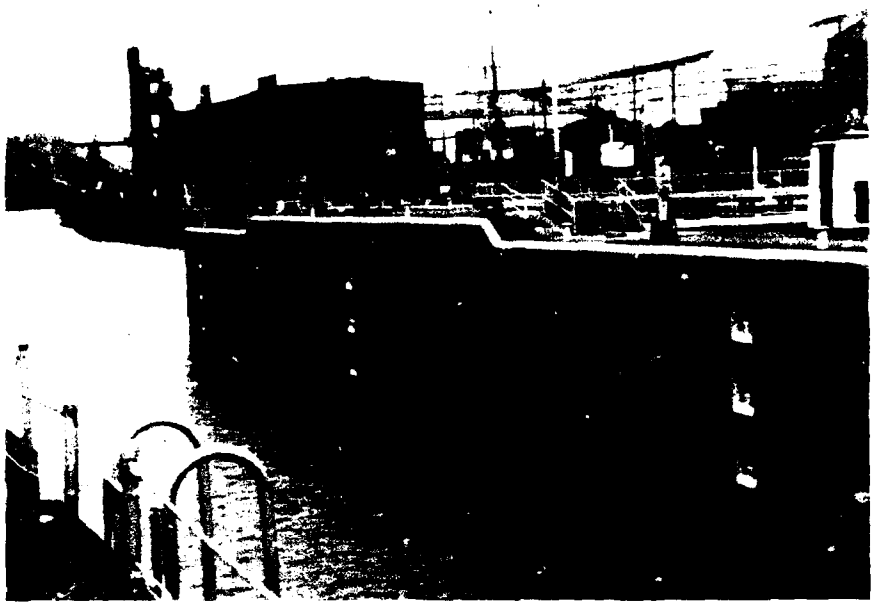


Photograph A6. Middle wall small lock chamber

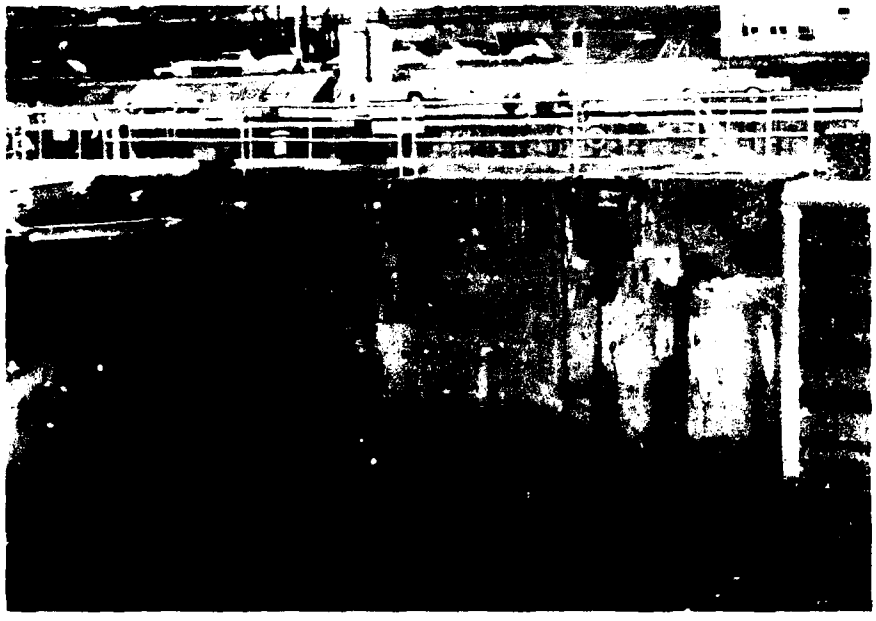


Photograph A7. Middle wall small lock chamber monolith M-16

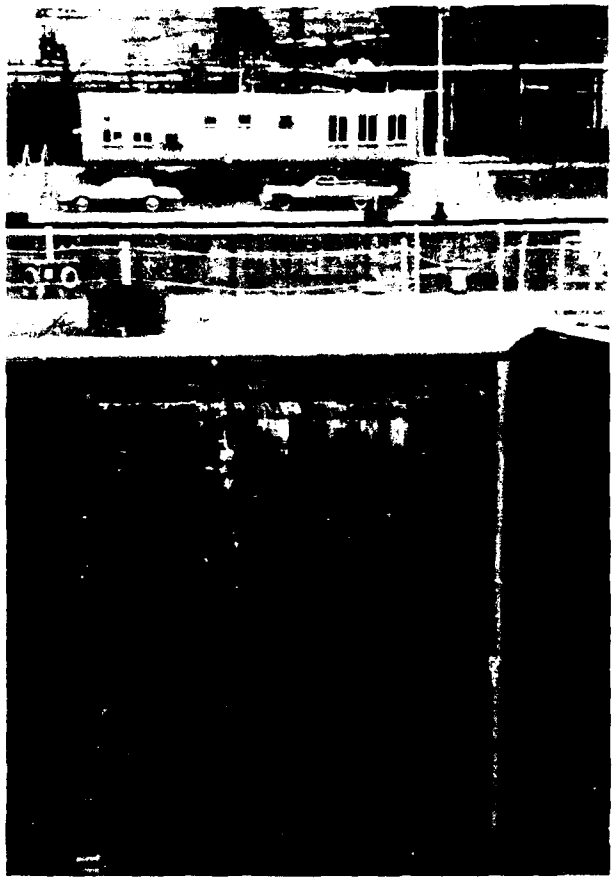
Photographs A8 & A9. Middle wall monolith M-22



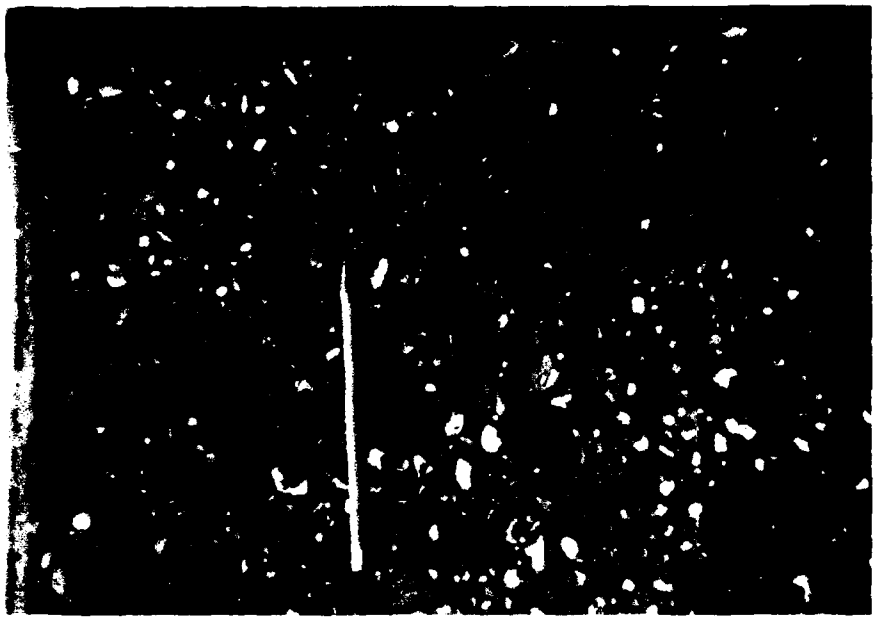
Photograph A10. Downstream of lower gates small lock chamber middle wall



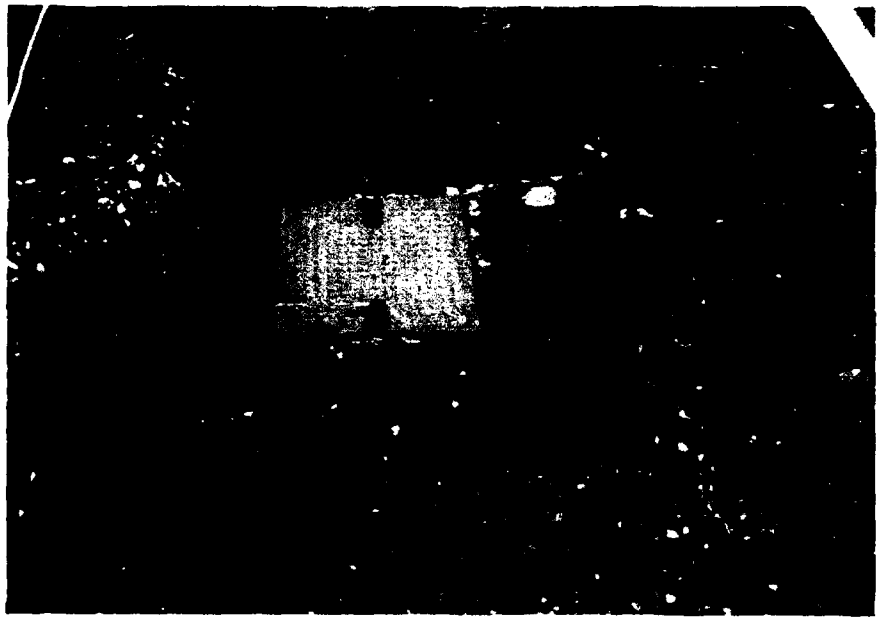
Photograph A11. Lower gate recess middle wall small lock chamber



Photograph A12. Downstream of lower gates of small lock chamber in middle wall

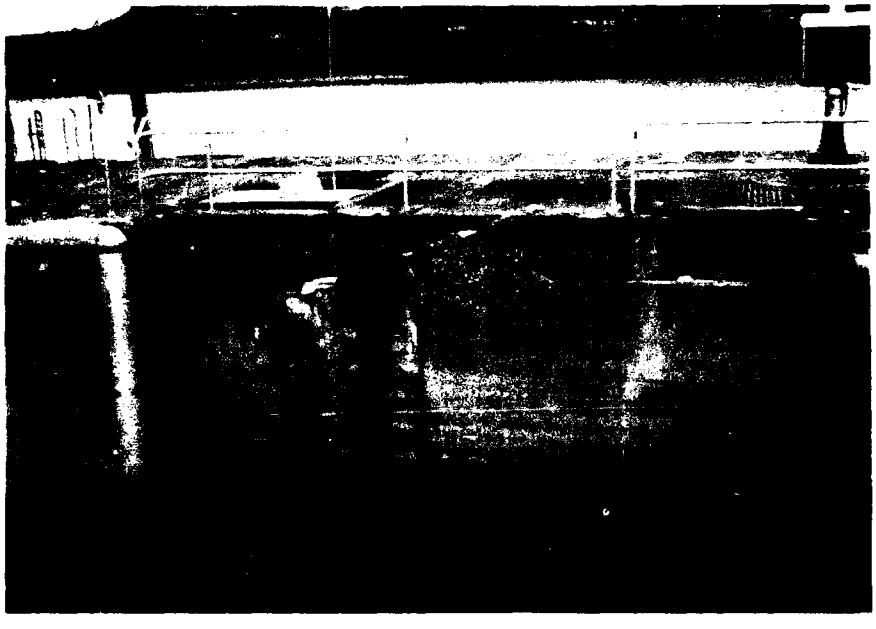


Photograph A13. Top of upper guard wall joint between monolith No. 8 and No. 7



Photograph A14. Top of upper guard wall monolith R-5

Photograph A15. River side upper guard wall

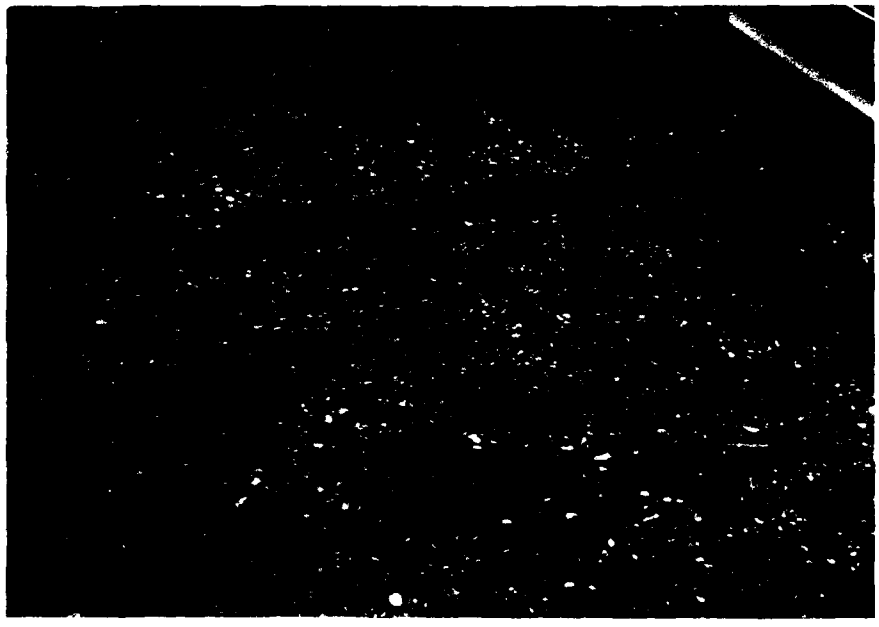


Photograph A16. Upper gate recess river wall

Photograph A17. Cracking near gate recess monolith R-12 of river wall

Photograph A18. Top of monolith R-13 river wall near upper gate recess

Photograph A19. Top monolith R-15 pop out

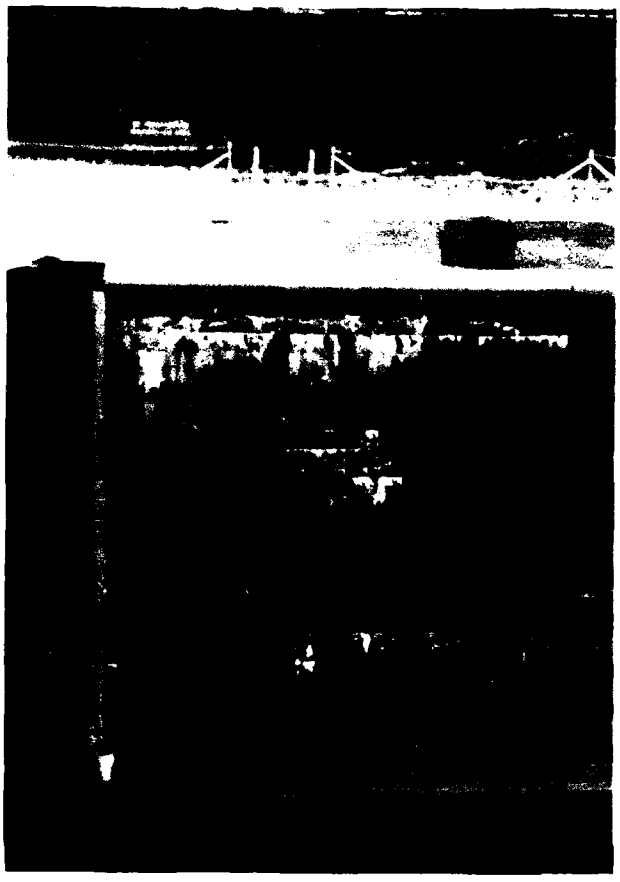


Photograph A20. Top monolith R-16 dissolution of aggregate

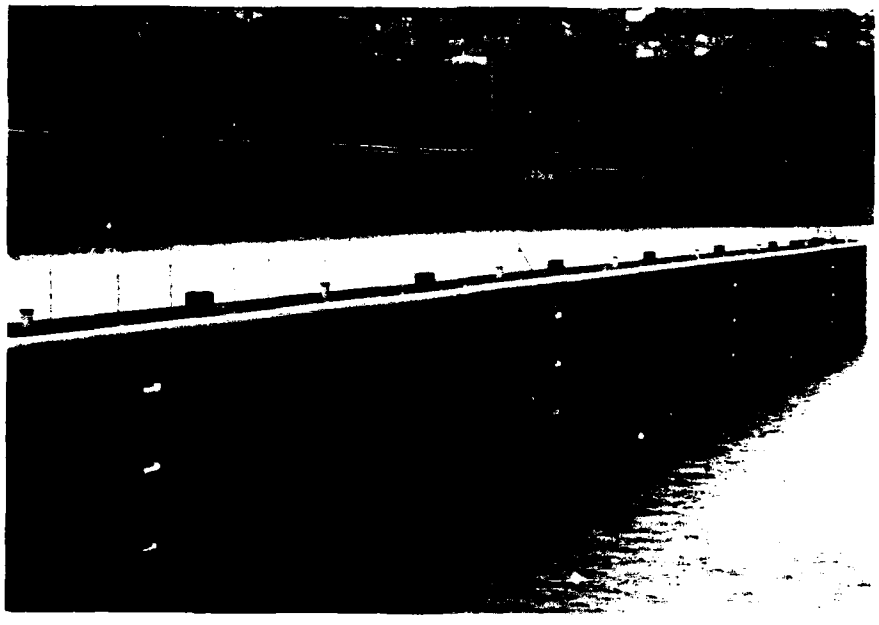
Photograph A21.

Photograph A22. River wall monolith R-23. Cracking and repairs of concrete in lower gate recess

Photograph A23. River wall lower gate recess



Photograph A24. River wall below lower gate



Photograph A25. Lower guard wall

APPENDIX B: FIELD DRILL LOGS

Hole No. L-1

DRILLING LOG	DIVISION Ohio River	INSTALLATION Lock & Dam #2	SHEET 1 OF 2 SHEETS
1. PROJECT Rehab. of Lock & Dam 2, Mon. River		10. SIZE AND TYPE OF BIT [illegible] Diamond	
2. LOCATION (Coordinates or Station) See Remarks		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY USAE-[illegible]S		12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500	
4. HOLE NO. (As shown on drawing title and this number) BR WES L-1		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 0	UNDISTURBED 0
5. NAME OF DRILLER Warhurst		14. TOTAL NUMBER CORE BOXES 4	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER n/a	
7. THICKNESS OF OVERBURDEN 0.0		16. DATE HOLE STARTED 17 Dec 85	COMPLETED 17 Dec 65
8. DEPTH DRILLED INTO ROCK 0.0		17. ELEVATION TOP OF HOLE 770.5 [illegible]	
9. TOTAL DEPTH OF HOLE 10.55' in Concrete		18. TOTAL CORE RECOVERY FOR BORING 100 %	
		19. SIGNATURE OF INSPECTOR [signature]	

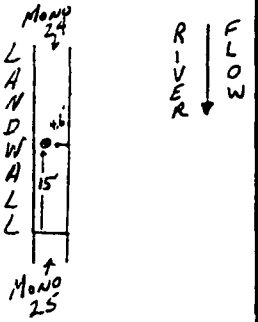
ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Descriptions)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	0.0		Surface Condition: slightly weathered with light scaling, maximum exposed aggregate size is ¾".			Run: 1 Begin: 0.0 End: 2.25 D.T: 15 min. Rec: 2.05 Remarks: Pulled off .2'.
	1.0		0.0 - 10.4 Concrete: gray, predominately crushed limestone aggregate, maximum aggregate size is 3", subangular to angular, has entrained air, has entrapped air, many voids generally less than ¼" diameter & deep, some aggregate are cracked,	100%	Box 1	
	2.0			Run 1		
	3.0					Run: 2 Begin: 2.25 End: 7.2 D.T: 45 min. Rec: 5.0 Remarks: Picked up .2' from run 1, pulled off .15' this run.
	4.0		@ 3.15: man made break.			
	5.0		@ 5.0: man made break.	100%	Box 2	
	6.0					
	7.0		@ 6.55: man made break.	Run 2	Box 3	Run: 3 Begin: 7.2 End: 10.55 D.T: 35 min. Rec: 3.35 Remarks: Picked up .15' from run 2, pulled off .15' this run & left it in the hole
	8.0		@ 8.75: 1" steel.	100%		
	9.0		@ 9.0: machine break.		Box 4	
			@ 9.4 & 9.8: 1" long void.			

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT Rehab. of Lock & Dam 2, Mon River | HOLE NO. BR-WES L-1

Hole No. L-1

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Lock & Dam #2	SHEET 2 OF 2 SHEETS
1. PROJECT: Rehab. of Lock & Dam 2, Mon. River		10. SIZE AND TYPE OF BIT: 6" Diamond	
2. LOCATION (Coordinates or Station): See Remarks		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL	
3. DRILLING AGENCY: USAE WES		12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500	
4. HOLE NO. (As shown on drawing title) and file number: BR WES L-1		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0	
5. NAME OF DRILLER: Warhurst		14. TOTAL NUMBER CORE BOXES: 4	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER: n/a	
7. THICKNESS OF OVERBURDEN: 0.0		16. DATE HOLE: STARTED 17 Dec 85; COMPLETED 17 Dec 85	
8. DEPTH DRILLED INTO ROCK: 0.0		17. ELEVATION TOP OF HOLE: 730.5'	
9. TOTAL DEPTH OF HOLE: 10.55' in Concrete		18. TOTAL CORE RECOVERY FOR BORING: 100 %	
		19. SIGNATURE OF INSPECTOR: [signature]	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	10.0					BOXES: 1. 0.0 - 3.15; 2. 3.15 - 6.55; 3. 6.55 - 9.0; 4. 9.0 - 10.4
	10.4		E.O.B. @ 10.55	Run 3		LOCATION:  ABBREVIATIONS D.T: drill time Rec: recovery E.O.B: end of boring.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: Rehab. of Lock & Dam 2, Mon. River | HOLE NO.: BR WES L-1

Hole No. BR WES L-2-86

DRILLING LOG

DIVISION: Ohio River	INSTALLATION: Locks & Dam No. 2, Monongahela RIver
	SHEET 1 OF 9 SHEETS
1. PROJECT: Rehabilitation of Locks & Dam No. 2 Monongahela RIver	10. SIZE AND TYPE OF BIT: 4 X 5"
2. LOCATION (Coordinates or Station): Landwall, monolith 28, 2.4' U.S. of Marker pen. 30.0' in from face.	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: USAE WES	12. MANUFACTURER'S DESIGNATION OF DRILL: Failing Truck - Mounted Rig
4. HOLE NO. (As shown on drawing title and file number): BR WES L-2-86	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 14; UNDISTURBED
5. NAME OF DRILLER: Gene Warhurst	14. TOTAL NUMBER CORE BOXES: 5
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.	15. ELEVATION GROUND WATER:
	16. DATE HOLE: STARTED 12 Feb 86; COMPLETED 17 Feb 86
7. THICKNESS OF OVERBURDEN: 59.7'	17. ELEVATION TOP OF HOLE: 730.5'
8. DEPTH DRILLED INTO ROCK: 20.8'	18. TOTAL CORE RECOVERY FOR BORING: 92 %
9. TOTAL DEPTH OF HOLE: 80.5'	19. SIGNATURE OF INSPECTOR: Tom C. Atkins

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
	1.0		Clayey mud, brown, slightly sandy	90	1	5-in. drive sample, using 300-lb hammer
	2.0		Blue-gray slag gravel with brown, clayey, sandy mud		2	
	5.0					Grind to 5.0 ft using 8 in. rock bit
	6.0		Clayey mud, brown, w/silt and sand mixed with black slag and sandstone gravel to 1-1/2 in., some blue-gray slag	70	3	5-in. drive sample, using 300-lb hammer
	8.0					Grind to 10.0 ft using 8 in. rock bit
	10.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: Rehabilitation of Locks & Dam No. 2, Monongahela River | HOLE NO. BR WES L-2-

Hole No. BR WES L-2-86

DRILLING LOG

DIVISION: Ohio River	INSTALLATION: Locks & Dam No. 2, Monongahela River
SHEET 2 OF 9 SHEETS	
1. PROJECT: Rehabilitation of Locks & Dam No. 2, Monongahela River	10. SIZE AND TYPE OF BIT: 5 X 5"
2. LOCATION: 2.4' U.S. of marker pen. 30.0' in from Landwall monolith 28	11. DATUM FOR ELEVATION SHOWN: MSL
3. DRILLING AGENCY: River Face. USAE - WES	12. MANUFACTURER'S DESIGNATION OF DRILL: Failing Truck - Mounted Rig
4. HOLE NO.: BR WES L-2-86	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER: Gene Warhurst	14. TOTAL NUMBER CORE BOXES: 5
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN: 59.7'	16. DATE HOLE: STARTED 12 Feb 86 / COMPLETED 17 Feb 86
8. DEPTH DRILLED INTO ROCK: 20.8'	17. ELEVATION TOP OF HOLE: 727.0'
9. TOTAL DEPTH OF HOLE: 80.5'	18. TOTAL CORE RECOVERY FOR BORING: 92 %
	19. SIGNATURE OF INSPECTOR: Mike C. Oliver

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	11.0		Sandstone gravel to 1-1/2 in. maximum diameter, pieces of orange brick, some 1/2 in. black slag	70	4	5-in. drive sample, using 300-lb hammer
	12.0		Clayey mud, brown, silty			
	13.0					Grind to 15.0-A, using 8-in. rock bit
	14.0					
	15.0					
	16.0		3-in. diameter piece of sandstone, smaller sandstone and mixed pea gravel	20	5	5-in. drive sample, using 300-lb hammer
	17.0					
	18.0					Grind to 20.0 ft, using 8-in. rock bit
	19.0					
	20.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: Rehabilitation of Locks and Dam No. 2, Monongahela River | HOLE NO.: BR WES L-2-

Hole No. BR WES L-2-86

DRILLING LOG	DIVISION Ohio River	INSTALLATION Locks & Dam No. 2, Monongahela River	SHEET 3 of 9 SHEETS
1. PROJECT Rehabilitation of Locks and Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT 4 X 5"	
2. LOCATION (Coordinates or Station) Landwall monolith 28, 2.4' U.S. of marker pen. 30.3' in fr. m river		11. DATUM FOR ELEVATION SHOWN (MSL or MLW) MSL	
3. DRILLING AGENCY USAE - WES		12. MANUFACTURER'S DESIGNATION OF DRILL FAiling Truck - Mounted Rig	
4. HOLE NO. (As shown on drawing title) and file number BR WES L-2-86		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED	UNDISTURBED
5. NAME OF DRILLER Gene Warhurst		14. TOTAL NUMBER CORE BOXES 5	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
		16. DATE HOLE STARTED 12 Feb 86 COMPLETED 17 Teb 86	
7. THICKNESS OF OVERBURDEN 59.7'		17. ELEVATION TOP OF HOLE 727.0'	
8. DEPTH DRILLED INTO ROCK 20.8'		18. TOTAL CORE RECOVERY FOR BORING 92 %	
9. TOTAL DEPTH OF HOLE 80.5'		19. SIGNATURE OF INSPECTOR Joyce C. Allwin	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	21.0					5-in. drive sample, using 300-lb hammer
	22.0			25	6	
	23.0		Large "brick" of slag material, 3 X 4 X 6-in.			
			Pea gravel to 1 in. maximum, mixed with slag with clayey mud			
			clayey mud, gray-brown, silty			
	24.0					Grind to 25.0 ft, using 8-in. rock bit
	25.0					
			Silty, clayey mud, black, with numerous flecks of steel throughout	100	7	2-1/2 in. splitspoon, using 300 lb hammer. Weight of hammer pushes sampler. No blows needed.
	26.0					
	27.0					
	28.0					
	29.0					
	30.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT)

PROJECT Rehabilitation of Locks and Dam No. 2, Monongahela River

HOLE NO. BR WES L-2-8

Hole No. BR WES L-2-86

DRILLING LOG	DIVISION Ohio River	INSTALLATION Locks & Dam No. 2, Monongahela River	SHEET 4 OF 9 SHEETS
1. PROJECT Rehabilitation of Locks and Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT 4 X 5"	
2. LOCATION (Coordinates or Station) Landwall, monolith 28, 2.4' U.S. of marker pen, 30.0' in from		11. DATUM FOR ELEVATION SHOWN (MSL or MLW) MSL	
3. DRILLING AGENCY River Lock USAE - WES		12. MANUFACTURER'S DESIGNATION OF DRILL Failing Truck - Mounted Rig	
4. HOLE NO. (As shown on drawing title) and file number BR WES L-2-86		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED	UNDISTURBED
5. NAME OF DRILLER Gene Warhurst		14. TOTAL NUMBER CORE BOXES 5	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN 59.7'		16. DATE HOLE: STARTED 12 Feb 86	COMPLETED 17 Feb 86
8. DEPTH DRILLED INTO ROCK 20.8'		17. ELEVATION TOP OF HOLE 727.0'	
9. TOTAL DEPTH OF HOLE 80.5'		18. TOTAL CORE RECOVERY FOR BORING 92 %	
		19. SIGNATURE OF INSPECTOR Joyce C. Oliver	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	31.0		Clayey mud, black to dark gray, with some silt	100	8	2-1/2 in. splitspoon, using 300-lb hammer, 4 blows
	32.0					
	33.0					Grind to 35.0 ft, using 8-in. rock bit
	34.0					
	35.0					
	36.0		Clayey mud, dark gray, sandy	100	9	
	37.0					
	38.0					Grind to 40.0 ft, using 8-in. rock bit
	39.0					
	40.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT Rehabilitation of Locks & Dam No 2, Monongahela River | HOLE NO. BR WES L-2-86

Hole No. BR WES L-2-86

DRILLING LOG

DIVISION: Ohio River

INSTALLATION: Locks & Dam No. 2, Mononganela River

SHEET 5 OF 9 SHEETS

1. PROJECT: Rehabilitation of Locks and Dam No. 2, Mononganela River
2. LOCATION (Coordinates or Station): Landwall, monolith 28, 2.4' U.S. of marker pen. 30.0' in from
3. DRILLING AGENCY: River Lace USAE WES
4. HOLE NO. (As shown on drawing title and file number): BR WES L-2-86
5. NAME OF DRILLER: Gene Warhurst
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: 59.7'
8. DEPTH DRILLED INTO ROCK: 20.8'
9. TOTAL DEPTH OF HOLE: 80.5'
10. SIZE AND TYPE OF BIT: 4 X 5"
11. DATUM FOR ELEVATION SHOWN (MSL or USC&GS): MSL
12. MANUFACTURER'S DESIGNATION OF DRILL: Failing Truck - Mounted Rig
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED _____ UNDISTURBED _____
14. TOTAL NUMBER CORE BOXES: 5
15. ELEVATION GROUND WATER: _____
16. DATE HOLE: STARTED 12 Feb 86 COMPLETED 17 Feb 86
17. ELEVATION TOP OF HOLE: 727.0'
18. TOTAL CORE RECOVERY FOR BORING: 92 %
19. SIGNATURE OF INSPECTOR: Joyce C. Wilson

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
	41.0		Clayey mud, dark gray	100	10	2-1/2 in. splitspoon, using 300-lb hammer 4 blows
	42.0					
	43.0					Grind to 45.0 ft, using 8-in. rock bit
	44.0					
	45.0					
	46.0		Very sandy, brown clayey mud with gravel to 1 in. maximum diameter on bottom	35	11	2-1/2 in. splitspoon, using 300-lb hammer 27 blows
	47.0					
	48.0					Grind to 50.0 ft using 8-in. rock bit
	49.0					
	50.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT Rehabilitation of Locks and Dam No. 2, Mononganela River — HOLE NO. BR WES L-2-86

Hole No. BR WES L-2-86

DRILLING LOG

DIVISION: Ohio River

INSTALLATION: Locks & Dam No. 2, Monongahela River

SHEET 6 OF 9 SHEETS

1. PROJECT: Rehabilitation of Locks and Dam No. 2, Monongahela River
2. LOCATION (Coordinates or Station): Langwall, spoolith 28, 2.4' U.S. of marker pen, 30.0' in from
3. DRILLING AGENCY: USAE WES
4. HOLE NO. (As shown on drawing title and file number): BR WES L-2-86
5. NAME OF DRILLER: Gene Warhurst
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: 59.7'
8. DEPTH DRILLED INTO ROCK: 20.8'
9. TOTAL DEPTH OF HOLE: 80.5'
10. SIZE AND TYPE OF BIT: 4 X 5"
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
12. MANUFACTURER'S DESIGNATION OF DRILL: Failing Truck - Mounted Rig
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED _____ UNDISTURBED _____
14. TOTAL NUMBER CORE BOXES: 5
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED 12 Feb 86 COMPLETED 17 Feb 86
17. ELEVATION TOP OF HOLE: 727.0'
18. TOTAL CORE RECOVERY FOR BORING: 92 %
19. SIGNATURE OF INSPECTOR: Joyce C. Wilson

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Descriptions) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	51.0		Mixed gravel, pea size Clayey mud, brown, very sandy, w/some blue-gray clay lumps	80	12	2-1/2 in. splitspoon, using 300-lb hammer 31 blows
	52.0					Grind to 55.0-ft, using 8-in. rock bit
	53.0					
	54.0					
	55.0		Mixed gravel, pea size Clayey mud, brown, sandy	80	13	2-1/2 in. splitspoon, using 300-lb hammer 31 blows
	56.0		Sand and pea gravel, mixed			
	57.0					Grind to 60.0 ft, using 8.0-in. rock bit
	58.0					
	59.0					
	60.0		Backfill-rock contact			59.7'-drill action becomes smooth, mud brings up clay-shale fragments

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: Rehabilitation of Locks and Dam No. 2, Monongahela River

HOLE NO.: BR WES L-2-

Hole No. BR WES L-2-86

DRILLING LOG

DIVISION: Ohio River

INSTALLATION: Locks & Dam No. 2, Monongahela River

SHEET 7 OF 9 SHEETS

1. PROJECT: Rehabilitation of Locks & Dam No. 2, Monongahela River
2. LOCATION (Coordinates or Station): Landwall, monolith 28, 2.4' U.S. of marker pen, 30.0' in from river face
3. DRILLING AGENCY: USAE WES
4. HOLE NO. (As shown on drawing title and file number): BR WES L-2-86
5. NAME OF DRILLER: Gene Warhurst
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: 59.7'
8. DEPTH DRILLED INTO ROCK: 20.8'
9. TOTAL DEPTH OF HOLE: 80.5'
10. SIZE AND TYPE OF BIT: 4 X 5"
11. DATUM FOR ELEVATION SHOWN (GS or MSL): MSL
12. MANUFACTURER'S DESIGNATION OF DRILL: Failing Truck - Mounted Rig
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED _____ UNDISTURBED _____
14. TOTAL NUMBER CORE BOXES: 5
15. ELEVATION GROUND WATER: _____
16. DATE HOLE: STARTED 12 Feb 86 COMPLETED 17 Feb 86
17. ELEVATION TOP OF HOLE: 727.0'
18. TOTAL CORE RECOVERY FOR BORING: 92 %
19. SIGNATURE OF INSPECTOR: Bruce C. Allbin

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
			Blue-gray clayey shale, soft	0	14	2-1/2 in. split spoon, using 300-lb hammer 48 blows
	61.0				Box 1	Run: 1 Begin: 60.3' End: 64.55 D.T.: 2 hr 6 min Rec: 4.25'
	62.0			85		
			Mottled gray and brown shale calcareous module			
	63.0		Brown shale, soft to moderately hard			
	64.0					
	65.0					
						Run: 2 Begin: 64.55' End: 68.20' D.T.: 1 hr 50 min Rec: 3.65'
	66.0		Gray shale, soft to moderately hard		Box 2	
	67.0			80		
	68.0					
			Gray shale, moderately hard, slightly silty			
	69.0					
	70.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: Rehabilitation of Locks & Dam No. 2, Monongahela River

HOLE NO. BR WES L-2-8

Hole No. BR WES L-2-86

DRILLING LOG

DIVISION: Ohio River

INSTALLATION: Locks & Dam No. 2, Monongahela River

SHEET 8 OF 9 SHEETS

1. PROJECT: Rehabilitation of Locks & Dam No. 2, Monongahela River
2. LOCATION (Coordinates or Station): Landwall, monolith 28, 2.4' U.S. of marker pen, 30.0' in from river face
3. DRILLING AGENCY: USAE WES
4. HOLE NO. (As shown on drawing title and file number): BR WES L-2-86
5. NAME OF DRILLER: Gene Warhurst
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: 59.7'
8. DEPTH DRILLED INTO ROCK: 20.8'
9. TOTAL DEPTH OF HOLE: 80.5'
10. SIZE AND TYPE OF BIT: 4 X 5"
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
12. MANUFACTURER'S DESIGNATION OF DRILL: Failing Truck - Mounted Rig
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED _____ UNDISTURBED _____
14. TOTAL NUMBER CORE BOXES: 5
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED 12 Feb 86 COMPLETED 17 Feb 86
17. ELEVATION TOP OF HOLE: 727.0'
18. TOTAL CORE RECOVERY FOR BORING: 92 %
19. SIGNATURE OF INSPECTOR: Joyce P. Wilson

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
	71.0		Gray shale, w/band of brown shale, moderately hard, slightly silty, some calcareous modules	95	Box 3	Run: 3 Begin: 68.2' End: 73.2' D.T.: 1 hr 18 min Rec: 4.45'
	72.0					
	73.0					
	74.0		Gray shale, moderately hard, some brown bands, slightly silty, some calcareous modules	100	Box 4	Run: 4 Begin: 72.65 End: 77.7 D.T.: 1 hr 10 min Rec: 4.85
	75.0					
	76.0					
	77.0		Brown shale, moderately hard			
	78.0		Gray shale, moderately hard, slightly silty	99	Box 5	Run: 5 Begin: 77.5' End: 80.5' D.T.: 51 min Rec: 3.0'
	79.0					
	80.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: Rehabilitation of Locks & Dam No. 2, Monongahela River

HOLE NO. BR WES L-2-86

Hole No. BR WES L-2-86

DRILLING LOG	DIVISION Ohio River	INSTALLATION Locks & Dam No. 2, Monongahela River	SHEET 9 OF 9 SHEETS
1. PROJECT Rehabilitation of Locks and Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT 4 X 5"	
2. LOCATION (Coordinates or Station) Landwall, monolith 28, 2.4' U.S. of marker pen, 30.0' in from		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY River Face USAE WES	—	12. MANUFACTURER'S DESIGNATION OF DRILL Failing Truck - Mounted Rig	
4. HOLE NO. (As shown on drawing title and file number)	BR WES L-2-86	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED — UNDISTURBED
5. NAME OF DRILLER Gene Warhurst	—	14. TOTAL NUMBER CORE BOXES 5	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
		16. DATE HOLE STARTED 12 Feb 86	COMPLETED 17 Feb 86
7. THICKNESS OF OVERBURDEN	59.7'	17. ELEVATION TOP OF HOLE 727.0'	
8. DEPTH DRILLED INTO ROCK	20.8'	18. TOTAL CORE RECOVERY FOR BORING 92 %	
9. TOTAL DEPTH OF HOLE	80.5'	19. SIGNATURE OF INSPECTOR [signature]	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Descriptions) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			E.O.B. 80.5'			

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PROJECT Rehabilitation of Locks & Dam No. 2, Monongahela River

HOLE NO. BR WES L-2-8

Hole No. L-3

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Lock & Dam #2	SHEET 1 OF 2 SHEETS
1. PROJECT: Rehab. of Lock & Dam 2, Mon. River		10. SIZE AND TYPE OF BIT: [illegible]	
2. LOCATION (Coordinates or Station): See remarks		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL	
3. DRILLING AGENCY: USAE-MOS		12. MANUFACTURER'S DESIGNATION OF DRILL: Acker Skid Rig	
4. HOLE NO. (As shown on drawing title and file number): BR WES L-3		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 3; UNDISTURBED 0	
5. NAME OF DRILLER: Dan Taylor		14. TOTAL NUMBER CORE BOXES: 3	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER: n/a	
7. THICKNESS OF OVERBURDEN: 0.0		16. DATE HOLE: STARTED 21 Oct 85; COMPLETED 24 Oct 85	
8. DEPTH DRILLED INTO ROCK: 15.0		17. ELEVATION TOP OF HOLE: 732.5	
9. TOTAL DEPTH OF HOLE: 15.0		18. TOTAL CORE RECOVERY FOR BORING: 100 %	
		19. SIGNATURE OF INSPECTOR: [signature]	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	0.0		Surface Condition: slightly weathered with medium scaling - maximum exposed aggregate size is 2". Surface crack with slight separation is within 3'.			Run: 1 Begin: 0.0 End: 2.3 D.T: 50 min. Rec: 1.8 Remarks: Pulled off .5'.
	1.0			100%		
	2.0		0.0 - 16.0 Concrete: gray, predominately crushed limestone aggregate, maximum aggregate size is 3", predominately subangular, good consolidation, entrapped and entrained air, many voids generally less than ¼" diameter & deep, some cracked aggregate.	Run 1	Box 1	
	3.0			100%		Run: 2 Begin: 2.3 End: 4.1 D.T: 35 min. Rec: 1.35 Remarks: Picked up .5' from run 1, pulled off .35' this run.
	4.0			Run 2		
	5.0			100%		Run: 3 Begin: 4.1 End: 6.2 D.T: 50 min. Rec: 2.25 Remarks: Picked up .35' from run 2, pulled off .2' this run.
	6.0			Run 3	Box 2	
	7.0		@ 6.65: manmade break. @ 7.3: manmade break.			Run: 4 Begin: 6.2 End: 11.2 D.T: 3 hrs 30 min. Rec: 4.9 Remarks: Picked up .2' from run 3, pulled off .3' this run.
	8.0			100%		
	9.0		@ 9.4: manmade break.		Box 3	

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PROJECT: Rehab. of Lock & Dam 2, Mon. River | HOLE NO.: BR WES L-3

Hole No. L-3

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Lock & Dam #2	SHEET 2 OF 2 SHEETS
1. PROJECT: Rehab. of Lock & Dam 2, Mon. River		10. SIZE AND TYPE OF BIT: 6" Diamond Bit	
2. LOCATION (Coordinates or Station): See Remarks		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL	
3. DRILLING AGENCY: USAE WES		12. MANUFACTURER'S DESIGNATION OF DRILL: Acker Skid Rig	
4. HOLE NO. (As shown on drawing title and file number): BR WES L-3		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 0 / UNDISTURBED 0	
5. NAME OF DRILLER: Dan Taylor –		14. TOTAL NUMBER CORE BOXES: 5	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER: n/a	
7. THICKNESS OF OVERBURDEN: 0.0'		16. DATE HOLE: STARTED 21 Oct 85 / COMPLETED 24 Oct 85	
8. DEPTH DRILLED INTO ROCK: 0.0'		17. ELEVATION TOP OF HOLE: 732.5'	
9. TOTAL DEPTH OF HOLE: 16.1'		18. TOTAL CORE RECOVERY FOR BORING: 100 %	
		19. SIGNATURE OF INSPECTOR:	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	10.0					
	11.0			Run 4		Run: 5 Begin: 11.2 End: 16.1 D.T: 1 hr 40 min. Rec: 3.1 Remarks: Picked up .2' from run 4, pulled off .1' this run. Drill action was smooth throughout boring. 100% of water was retained.
	12.0		@ 11.45: low angle crack.		Box 4	
	13.0		@ 12.85: manmade break.			
			@ 13.7: 1½" long void.	100%		ABBREVIATIONS: D.T: drill time Rec: recovery E.O.B: end of boring.
	14.0		@ 14.0: 1" long void. @ 14.15: manmade break.			
	15.0				Box 5	BOXES: 1. 0.0 - 3.75 2. 3.75 - 7.3 3. 7.3 - 10.9 4. 10.9 - 14.15 5. 14.15 - 16.0
	16.0		E.O.B. @ 16.1'	Run 5		LOCATION: Large Chamber flow → 4.1' ← 9' → mono. 33 | mono. 34 Landwall

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: Rehab of Lock & Dam 2, Mon. River | HOLE NO.: BR WES L-3

Hole No. --

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Lock & Dam #2	SHEET 1 OF 1 SHEETS
1. PROJECT: Rehab. of Lock & Dam 2, Mon. River		10. SIZE AND TYPE OF BIT: 6" diamond bit	
2. LOCATION (Coordinates or Station): See Remarks		11. DATUM FOR ELEVATION SHOWN (USGS or USC&GS): MSL	
3. DRILLING AGENCY: USAE-WES		12. MANUFACTURER'S DESIGNATION OF DRILL: MOR-IT, Series A-100, 115 volt	
4. HOLE NO. (As shown on drawing title) and file number: BR WES L-4		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0	
5. NAME OF DRILLER: Dan Taylor		14. TOTAL NUMBER CORE BOXES: 1	
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED 90 DEG. FROM VERT. Horizontal		15. ELEVATION GROUND WATER: N/A	
7. THICKNESS OF OVERBURDEN: 0.0		16. DATE HOLE: STARTED 21 Oct 85; COMPLETED 21 Oct 85	
8. DEPTH DRILLED INTO ROCK: 3.0		17. ELEVATION TOP OF HOLE: [illegible]	
9. TOTAL DEPTH OF HOLE: 3.2' in Concrete		18. TOTAL CORE RECOVERY FOR BORING: 100 %	
		19. SIGNATURE OF INSPECTOR: [signature]	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	0.0		Surface Condition: moderately weathered with some exposed agg. - max. agg. size is 2".	100%		Run: 1 Begin: 0.0 End: 1.15 D.T.: 55 min. Rec: 1.05 Remarks: Pulled off .1'.
	1.0		0.0 - 3.15 Concrete: gray with darker gray agg., predominately crushed limestone agg., max. agg. size is 2", predominately subangular, good consolidation, entrapped & entrained air, many voids - none greater than ¼" diameter & deep, @ 2.0: void is filled with wood.	Run 1	Box 1	Run: 2 Begin: 1.15 End: 3.2 D.T.: 1hr 10min. Rec: 2.1 Remarks: Picked up .1' from run 1, pulled off .05' this run. 100% of water was retained throughout boring. Drill action was smooth throughout boring.
	2.0			100%		
	3.0			Run 2		
			E.O.B. @ 3.2'			

LOCATION:

Middlewall

Large Chamber

— flow →

15'

mono. 18' mono.

37 Landwall 38

ABBREVIATIONS:
max: maximum
agg: aggregate
D.T: drill time
Rec: recovery
E.O.B: end of boring.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: Rehab. of Lock & Dam 2, Mon. River | HOLE NO.: BR WES L-4

Hole No. BR WES L-5-88

DRILLING LOG	DIVISION Ohio River	INSTALLATION Locks & Dam No. 2, Monongahela River	SHEET 1 OF 8 SHEETS
1. PROJECT Rehabilitation of Locks & Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT 4 X 5"	
2. LOCATION (Coordinates or Station) Landwall, monolith 43, 42' in from river face and 12' U.S. of monolith joint		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY USAE WES		12. MANUFACTURER'S DESIGNATION OF DRILL Failing Truck - Mounted Rig	
4. HOLE NO. (As shown on drawing title) and file number) BR WES L-88		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 12	UNDISTURBED
5. NAME OF DRILLER Gene Warhurst		14. TOTAL NUMBER CORE BOXES 7	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
		16. DATE HOLE STARTED 18 Jan 86	COMPLETED 10 Feb 86
7. THICKNESS OF OVERBURDEN 54.9'		17. ELEVATION TOP OF HOLE 730.5'	
8. DEPTH DRILLED INTO ROCK 18.3'		18. TOTAL CORE RECOVERY FOR BORING Rock 80 %	
9. TOTAL DEPTH OF HOLE 73.2'		19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	0.0		Concrete, surface intact, crushed L.S. agg, maximum 1", concrete brown w/dark gray bank 0.5-0.6'. Entrapped air voids, maximum 1/4", no entrained air.	100	Box 1	Run: 1 Begin: 0.0' End: 0.6'
				10	Sample 1	D.T.: 3 min Rec: 0.6'
	1.0		Clayey gravel, some slag, brown, maximum			Comments: water runs out of cracks between slabs
	2.0					2-1/2" splitspoon pushed pushed in w/kelly
	3.0					
	4.0					Grind to 5.1-ft using 8-in. rock bit. Expect to hit second slab, but do not
	5.0					
			Clayey gravel, 2 pieces sandstone, brown, maximum 1-1/2 in.	20	Sample 2	2-1/2" splitspoon using 150-lb hammer
	6.0					
	7.0					Grind to 10.0-ft using 8" rock bit
	8.0					
	9.0					
	10.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT Rehabilitation of Locks & Dam No. 2, Monongahela River | HOLE NO. BR WES L-5-88

Hole No. BR WES L-5-8

DRILLING LOG	DIVISION Ohio River	INSTALLATION Locks & Dam No. 2, Monongahela River	SHEET 2 OF 8 SHEETS
1. PROJECT Rehabilitation of Locks & Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT 4 X 5"	
2. LOCATION (Coordinates or Station) Landwall, monolith 43, 42' in from river face, 12' U.S. of monolith joint		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY USAE WES		12. MANUFACTURER'S DESIGNATION OF DRILL Failing Truck - Mounted Rig	
4. HOLE NO. (As shown on drawing title) and file number	BR WES L-5-86	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 12	UNDISTURBED
5. NAME OF DRILLER Gene Washurst		14. TOTAL NUMBER CORE BOXES 7	
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
		16. DATE HOLE STARTED 18 Jan 86	COMPLETED 10 Feb 86
7. THICKNESS OF OVERBURDEN	54.9'	17. ELEVATION TOP OF HOLE 730.5'	
8. DEPTH DRILLED INTO ROCK	18.3'	18. TOTAL CORE RECOVERY FOR BORING Rock 80 %	
9. TOTAL DEPTH OF HOLE	73.2'	19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	11.0		Gray clay, S.S. gravel, maximum size 1", some slag, pieces of broken bricks	80	Sample 3	5" drive sample, using 300-lb hammer
	12.0					
	13.0					Grind to 15.0' using 8" rock bit Bit brings up slag, 2-4" in diameter and 1/2" to 1" pieces of steel
	14.0					
	15.0					
	16.0		Slag and steel pieces Slag 3-4-1/2" diameter Steel 1/2-1-1/4" diameter	50	Sample 4	5" drive sample, using 300-lb hammer
	17.0					
	18.0					Grind to 20.0', using 8" rock bit
	19.0					
	20.0					

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PROJECT Rehabilitation of Locks & Dam No. 2, Monongahela River | HOLE NO. BR WES L-5-

Hole No. BR WES L-5-86

DRILLING LOG	DIVISION Ohio River	INSTALLATION Locks & Dam No. 2, Monongahela River	SHEET 3 OF 8 SHEETS
1. PROJECT Rehabilitation of Locks & Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT 4 X 5"	
2. LOCATION (Coordinates or Station) Landwall, monolith 43, 42' in from river face, 12' U.S. of monolith joint		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY USAE WES		12. MANUFACTURER'S DESIGNATION OF DRILL Failing Truck - Mounted Rig	
4. HOLE NO. (As shown on drawing title) and Bio number BR WES L-5-86		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 12	UNDISTURBED
5. NAME OF DRILLER Gene Warhurst		14. TOTAL NUMBER CORE BOXES 7	
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
		16. DATE HOLE STARTED 18 Jan 86	COMPLETED 10 Feb 86
7. THICKNESS OF OVERBURDEN 54.9'		17. ELEVATION TOP OF HOLE 730.5'	
8. DEPTH DRILLED INTO ROCK 18.3'		18. TOTAL CORE RECOVERY FOR BORING Rock 80 %	
9. TOTAL DEPTH OF HOLE 73.2'		19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
						Grind out casing with 8" rock bit
	21.0		Slag, 3-4" in diameter, steel fragments to 1-1/2" diameter	75	Sample 5	5" drive sample, using 300-lb hammer
	22.0					
	23.0					Grind to 25.6", using 8" rock bit
	24.0					
	25.0					
	26.0		Slag, 2-3" diameter, steel fragments to 1-1/2" diameter	75	Sample 6	5" drive sample, using 300-lb hammer
	27.0					
	28.0					Grind to 30.0', using 8" rock bit
	29.0					
	30.0					

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PROJECT Rehabilitation of Locks & Dam No. 2, Monongahela River | HOLE NO. BR WES L-5-86

Hole No. BR WES L-5-86

DRILLING LOG | DIVISION Ohio River | INSTALLATION Locks & Dam No. 2, Monongahela River | SHEET 4 OF 8 SHEETS

1. PROJECT Rehabilitation of Locks & Dam No. 2, Monongahela River
2. LOCATION (Coordinates or Station) Landwall, monolith 43, 42' in from river face, 12' U.S. of monolith joint
3. DRILLING AGENCY USAE WES
4. HOLE NO. (As shown on drawing title) and file number: BR WES L-5-86
5. NAME OF DRILLER Gene Warhurst
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN 54.9'
8. DEPTH DRILLED INTO ROCK 18.3'
9. TOTAL DEPTH OF HOLE 73.2'
10. SIZE AND TYPE OF BIT 4 X 5"
11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
12. MANUFACTURER'S DESIGNATION OF DRILL Failing Truck - Mounted Rig
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 12; UNDISTURBED
14. TOTAL NUMBER CORE BOXES 7
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED 18 Jan 86; COMPLETED 10 Feb 86
17. ELEVATION TOP OF HOLE 730.5'
18. TOTAL CORE RECOVERY FOR BORING Rock 80 %
19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	31.0		One large piece of slag, 5" diameter, steel fragments to 2" diameter	75	Sample 7	5" drive sample using 300-lb hammer
	32.0					Grind to 35.2' using 8" rock bit
	33.0					
	34.0					
	35.0					
	36.0		Silty clay, grayish-brown, slag pieces to 2" maximum diameter	90	Sample 8	5" drive sample, using 300-lb hammer
	37.0					
	38.0					Grind to 40' using 8" rock bit
	39.0					
	40.0					

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PROJECT Rehabilitation of Locks & Dam No. 2, Monongahela River | HOLE NO. BR WES L-5-

Hole No. [illegible] L-5-86

DRILLING LOG	DIVISION Ohio River	INSTALLATION Locks & Dam No. 2, Monongahela River	SHEET 5 OF 8 SHEETS
1. PROJECT Rehabilitation of Locks & Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT [illegible]	
2. LOCATION (Coordinates or Station) Landwall, monolith 43, 42' in from river face, 12' U.S. of expansion joint		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY USAE WES		12. MANUFACTURER'S DESIGNATION OF DRILL Failing Truck - Mounted Rig	
4. HOLE NO. (As shown on drawing title) and file number BR WES L-5-86		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 12	UNDISTURBED
5. NAME OF DRILLER Gene Warhurst		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN 54.9'		16. DATE HOLE STARTED 18 Jan 86	COMPLETED 10 Feb 86
8. DEPTH DRILLED INTO ROCK 18.3'		17. ELEVATION TOP OF HOLE 730.5'	
9. TOTAL DEPTH OF HOLE 73.2'		18. TOTAL CORE RECOVERY FOR BORING Rock 80 %	
		19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	41.0		Clay, s.s. gravel to 1-1/2", small slag pieces, to 1/2" maximum	75	Sample 9	2-1/2 in. splitspoon using 300-lb hammer
	42.0					Grind to 43.0-ft using 8-in. rock bit
	43.0		Brown clay, mixed gravel, pea size to 1-1/2", s.s., some crushed	75	Sample 10	2-1/2" drive sample using 300-lb hammer
	44.0					
	45.0					
	46.0					Grind to 48.5-ft using 8" rock bit
	47.0					
	48.0					
	49.0		Pea gravel, siliceous, may be fall-in. One large piece of sandstone	50	Sample 11	
	50.0					

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PROJECT Rehabilitation of Locks & Dam No. 2, Monongahela River | HOLE NO. BR WES L-5-86

Hole No. [illegible]

DRILLING LOG	DIVISION Ohio River	INSTALLATION Locks & Dam No. 2, Monongahela River	SHEET 9 OF 8 SHEETS
1. PROJECT Rehabilitation of Locks & Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT 4 X 5"	
2. LOCATION (Coordinates or Station) Landwall, monolith 43, 42' in from river face, 12' U.S. of monolith joint		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY USAE WES		12. MANUFACTURER'S DESIGNATION OF DRILL Failing Truck - Mounted Rig	
4. HOLE NO. (As shown on drawing title) and Sht number BR WES L-5-86		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 12	UNDISTURBED
5. NAME OF DRILLER Gene Warhurst		14. TOTAL NUMBER CORE BOXES 7	
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN 54.9'		16. DATE HOLE STARTED 18 Jan 86	COMPLETED 10 Feb 86
8. DEPTH DRILLED INTO ROCK 18.3'		17. ELEVATION TOP OF HOLE 730.5'	
9. TOTAL DEPTH OF HOLE 73.2'		18. TOTAL CORE RECOVERY FOR BORING Rock 80 %	
		19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	51.0					Grind to 53.5' using 8" rock bit
	52.0					
	53.0					
	54.0		Clayey mud, brownish-gray, w/sand and s.s. gravel to maximum 1" diameter	85	Sample 12	2-1/2" drive sample using 300-lb hammer
	55.0		Clayey shale, greenish-blue, soft Rubble-gray shale w/iron staining, moderately hard, friable	80		Run: 2 Begin: 55.0' End: 57.0' D.T.: 33 min Rec: 1.4'
	56.0		Gray shale, moderately hard, breaks at 20° angle along iron-stained bands.			
	57.0		} cored over		Box 2	
			Iron-stained crumbly, broken up, brown shale	80		Run: 3 Begin: 56.4' End: 58.5' D.T.: 25 min Rec: 2.0'
	58.0		Healed verticle joint Vertical joint, open, horizontal crack, open			Run: 4 Begin: 58.4' End: 59.5' D.T.: 54 min Rec: 1.4'
	59.0		Shale, blue-gray, soft, clayey Vertical joint-all rubble	80		
	60.0					

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PROJECT Rehabilitation of Locks & Dam No. 2, Monongahela River | HOLE NO. BR WES L-5-[illegible]

Hole No. BR WES L-5-86

DRILLING LOG	DIVISION Ohio River	INSTALLATION Locks & Dam No. 2, Monongahela River	SHEET 7 OF 8 SHEETS
1. PROJECT Rehabilitation of Locks & Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT NX 3"	
2. LOCATION (Coordinates or Station) Landwall, monolith 43, 42' in from river face, 12' U.S. of monolith joint		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY USAE WES		12. MANUFACTURER'S DESIGNATION OF DRILL Failing Truck - Mounted Rig	
4. HOLE NO. (As shown on drawing title) and file number) BR WES L-5-86		13. TOTAL NO OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 2	UNDISTURBED
5. NAME OF DRILLER Gene Warhurst		14. TOTAL NUMBER CORE BOXES 7	
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN 54.9'		16. DATE HOLE STARTED 18 Jan 86	COMPLETED 10 Feb 86
8. DEPTH DRILLED INTO ROCK 18.3'		17. ELEVATION TOP OF HOLE 730.5'	
9. TOTAL DEPTH OF HOLE 73.2'		18. TOTAL CORE RECOVERY FOR BORING Rock 80 %	
		19. SIGNATURE OF INSPECTOR	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
			Shale, blue-gray, soft, vertical joint-open	80	Box 3	Run: 5 Begin: 59.5' End: 61.0' D.T.: 1 hr 8 min Rec: 1.0'
	61.0		Rubble			
			Calcareous nodules	80		Run: 6 Begin: 60.5' End: 62.5' D.T.: 59 min Rec: 1.7'
	62.0		Rubble			
	63.0		Rubble	80	Box 4	Run: 7 Begin: 62.2' End: 63.75' D.T.: 1 hr 1 min Rec: 1.1'
	64.0			80		Run: 8 Begin: 63.75 End: 65.80 D.T.: 39 min Rec: 1.58'
	65.0		Brown-stained area, calcareous nodules, healed horizontal fractures			
	66.0		Blue-gray shale, soft to moderately hard, numerous healed horizontal fractures, brown staining and calcareous inclusions	80		Run: 9 Begin: 65.33 End: 66.91 D.T.: 51 min Rec: 1.58'
	67.0		Shale, brown, moderately hard	80	Box 5	Run: 10 Begin: 66.91 End: 67.41 D.T. 25 min Rec: 0.49'
			Rubble			
	68.0			80		Run: 11 Begin: 67.41' End: 70.0' D.T.: 53 min Rec: 1.39'
			Shale, blue-gray, moderately hard			
	69.0		Brown shale, rubble			
			Gray shale, soft to moderately hard	80		
	70.0				Box	

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PROJECT Rehabilitation of Locks & Dam No. 2, Monongahela River

HOLE NO. BR WES L-5-8

Hole No. BR WES L-5-8

DRILLING LOG

Division	Ohio River
Installation	Locks & Dam No. 2, Monongahela River
Sheet	8 of 8 sheets
1. Project	Rehabilitation of Locks & Dam No. 2, Monongahela River
2. Location (Coordinates or Station)	Landwall, monolith 43, 42' in from river face, 12' U.S. of monolith joint
3. Drilling Agency	USAE WES
4. Hole No. (As shown on drawing title) and file number	BR WES L-5-86
5. Name of Driller	Gene Warhurst
6. Direction of Hole	☐ Vertical ☐ Inclined ____ deg. from vert.
7. Thickness of Overburden	54.9'
8. Depth Drilled into Rock	18.3'
9. Total Depth of Hole	73.2'
10. Size and Type of Bit	4" X 5"
11. Datum for Elevation Shown (MSL or MLW)	MSL
12. Manufacturer's Designation of Drill	Failing Truck - Mounted Rig
13. Total No. of Overburden Samples Taken	Disturbed: 12; Undisturbed:
14. Total Number Core Boxes	-
15. Elevation Ground Water	
16. Date Hole	Started: 18 Jan 86; Completed: 10 Feb 86
17. Elevation Top of Hole	730.5'
18. Total Core Recovery for Boring	Rock 80 %
19. Signature of Inspector	

Elevation (a)	Depth (b)	Legend (c)	Classification of Materials (Description) (d)	% Core Recovery (e)	Box or Sample No. (f)	Remarks (Drilling time, water loss, depth of weathering, etc., if significant) (g)
			Brown & gray rubble		6	Run: 12 Begin: 68.8' End: 70.4' D.T.: 49 min Rec: 1.6'
			Gray shale			
			Brown shale, rubble	80		
	71.0		Gray shale, soft to moderately hard			
			Brown shale, rubble, mottled with gray		Box 7	Run: 13 Begin: 70.4' End: 71.7' D.T.: 40 min Rec: 1.3'
	72.0			80		
			Gray shale, soft to moderately hard			
	73.0					Run: 14 Begin: 71.7' End: 73.2' D.T.: 45 min Rec: 1.5'

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Project: Rehabilitation of Locks & Dam No. 2, Monongahela River — Hole No.: BR WES L-5-8

Hole No. [illegible]

DRILLING LOG	DIVISION Ohio River	INSTALLATION Lock & Dam #2	SHEET 1 OF 1 SHEETS
1. PROJECT: Rehab. of Lock & Dam 2, Mon. River		10. SIZE AND TYPE OF BIT [illegible]	
2. LOCATION (Coordinates or Station): See Remarks		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL	
3. DRILLING AGENCY: USAE-WES		12. MANUFACTURER'S DESIGNATION OF DRILL: Acker-II, Series A-100, 110 volt	
4. HOLE NO. (As shown on drawing title) and file number: BR WES L-6		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 3	UNDISTURBED 0
5. NAME OF DRILLER: Dan Taylor		14. TOTAL NUMBER CORE BOXES: 1	
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED 90 DEG. FROM VERT. Horizontal		15. ELEVATION GROUND WATER: n/a	
7. THICKNESS OF OVERBURDEN: 0.0		16. DATE HOLE: STARTED 19 Oct 65 COMPLETED 20 Oct 65	
8. DEPTH DRILLED INTO ROCK: 2.55		17. ELEVATION TOP OF HOLE: [illegible]	
9. TOTAL DEPTH OF HOLE: 2.55' in Concrete		18. TOTAL CORE RECOVERY FOR BORING: 100 %	
		19. SIGNATURE OF INSPECTOR: [illegible]	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	0.0		Surface Condition: moderately weathered with exposed agg. - max. agg. size is 2". Few cracks with silent separation are nearby.	100% Run 1	Box 1	Run: 1 Begin: 0.0 End: 1.15 D.T.: 40 min. Rec: 1.15 Remarks: -
	1.0					
			0.0 - 2.55 Concrete: gray, predominately crushed limestone agg., max. agg. size is 3", predominately subangular good consolidation, entrapped air, entrained air, many voids - none greater than ¼" diameter & deep, some agg. are cracked.	100% Run 2		Run: 2 Begin: 1.15 End: 2.55 D.T.: 1 hr 20 min Rec: 1.4' Remarks: Drill action was smooth throughout boring. 100% of water was retained.
	2.0					
	2.55		E.O.B. @ 2.55'			ABBREVIATIONS: agg: aggregate max: maximum D.T.: drill time Rec: recovery E.O.B.: end of boring.
						LOCATION: Large Chamber flow → K-212' mono. 47 DAM FACE

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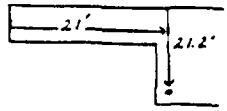
PROJECT: Rehab. of Lock & Dam 2, Mon. River | HOLE NO.: BR WES L-6

Hole No. ...-7

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Lock & Dam #2	SHEET 1 OF 1 SHEETS
1. PROJECT: Rehab. of Lock & Dam 2, Mon. River		10. SIZE AND TYPE OF BIT: 6" Diamond bit	
2. LOCATION (Coordinates or Station): See Remarks		11. DATUM FOR ELEVATION SHOWN (MSL or MLW): MSL	
3. DRILLING AGENCY: USAE-WES		12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500	
4. HOLE NO. (As shown on drawing title and file number): BR WES L-7		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0	
5. NAME OF DRILLER: Harnurst		14. TOTAL NUMBER CORE BOXES: 3	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER: n/a	
7. THICKNESS OF OVERBURDEN		16. DATE HOLE: STARTED 26 NOV 85; COMPLETED 2 DEC 85	
8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE: 730.5'	
9. TOTAL DEPTH OF HOLE: 6.5' into Concrete		18. TOTAL CORE RECOVERY FOR BORING: 100%	
		19. SIGNATURE OF INSPECTOR: [signature]	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Descriptions)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	0.0		Surface Condition: slightly weathered with light scaling. Exposed aggregate generally less than ¾".			
	1.0		0.0 - 6.5 Concrete: gray, predominately crushed limestone aggregate, maximum aggregate size is 3", subangular to angular, good consolidation, entrapped & entrained air, some aggregate are cracked, scattered voids - none larger than ¾" deep & diameter unless noted.	100% Run 1	Box 1	RUN: 1 Begin: 0.0 End: 2.25 D.T: 20 min. Rec: 2.15 Remarks: Pulled off hole without pulling core on 27 Nov 85. On 2 Dec 85 pulled run 1, 2.15' Pulled off .1'.
	2.0					Run: 2 Begin: 2.25 End: 4.35 D.T: 20 min. Rec: 2.2 Remarks: Picked up .1' from run 1.
	3.0				Box 2	
	4.0			100% Run 2		
	5.0			100%	Box 3	Run: 3 Begin: 4.35 End: 6.5 D.T: 2 hrs. Rec: 2.15 Remarks: Water loss beginning @ 5.5'; encountered drain pipe(steel walled) @ 5.4'.
	6.0		5.4 - 6.5: encountered 5" pipe(i.d.) with 3/8" steel wall.			
	6.5		E.O.B. @ 6.5'	Run 3		BOXES: 1. 0.0 - 2.15 2. 2.15 - 4.35 3. 4.35 - 6.5 Note: Hole abandoned & relocated 2.5' downstream, see hole L-7A. LOCATION: Large Chamber Flow Monolith 49 

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PROJECT: Rehab of Lock & Dam 2, Mon. River | HOLE NO.: BR WES L-7A

Hole No. -

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Lock & Dam -2	SHEET: OF 12 SHEETS
1. PROJECT: Rehab. of Lock & Dam 2, Mon. River		10. SIZE AND TYPE OF BIT: [illegible]	
2. LOCATION (Coordinates or Station): See Remarks		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL	
3. DRILLING AGENCY: USAE-LRD		12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500	
4. HOLE NO. (As shown on drawing title) and this number: BR WES L-7A		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED: - UNDISTURBED: -	
5. NAME OF DRILLER: Barnhurst		14. TOTAL NUMBER CORE BOXES:	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER:	
7. THICKNESS OF OVERBURDEN: 58.9' Concrete		16. DATE HOLE: STARTED: 15 Dec 85 COMPLETED:	
8. DEPTH DRILLED INTO ROCK: 60.6'		17. ELEVATION TOP OF HOLE: [illegible]	
9. TOTAL DEPTH OF HOLE: 119.5'		18. TOTAL CORE RECOVERY FOR BORING: Rock 98 %	
		19. SIGNATURE OF INSPECTOR:	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	0.0		Surface Condition: slightly weathered with light scaling. Maximum aggregate size is generally less than 1" (exposed).			
	1.0		0.0 - Concrete: gray, maximum aggregate size is 3", good consolidation, entrapped air.	100%	Box 1	Run: 1 Begin: 0.0 End: 2.2 D.T: 15 min. Rec: 2.2 Remarks: --
	2.0			Run 1		
	3.0		2.2 - 39.5: predominately crushed limestone aggregate, subangular to angular, entrained air, many voids generally less than 1" diameter & deep, some aggregate are cracked.	100%	Box2	Run: 2 Begin: 2.2 End: 4.35 D.T: 25 min. Rec: 2.1 Remarks: Worked on the catcher. Pulled off .05'.
	4.0		@ 2.4: 1" long void.	Run 2		
	5.0			100%	Box3	Run: 3 Begin: 4.35 End: 9.2 D.T: 30 min. Rec: 4.85 Remarks: Picked up .05' from run 2, pulled off .05' this run.
	6.0					
	7.0					
	8.0		@ 7.85: man made break.		Box 4	
				Run 3		

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PROJECT: Rehab. of Lock & Dam 2, Mon. River | HOLE NO.: BR WES L-7A

Hole No. [illegible]

DRILLING LOG	DIVISION Ohio River	INSTALLATION Lock & Dam #2	SHEET 2 OF 12 SHEETS

1. PROJECT Rehab. of Lock & Dam 2, Mon. River	10. SIZE AND TYPE OF BIT 6" Diamond Bit
2. LOCATION (Coordinates or Station) See Remarks	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
3. DRILLING AGENCY USAE WES	12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500
4. HOLE NO. (As shown on drawing title) and file number BR WES L-7A	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0
5. NAME OF DRILLER Warhurst	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☑ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN 58.9' Concrete	16. DATE HOLE STARTED 3 Dec 85; COMPLETED
8. DEPTH DRILLED INTO ROCK 60.6'	17. ELEVATION TOP OF HOLE 730.5'
9. TOTAL DEPTH OF HOLE 119.5'	18. TOTAL CORE RECOVERY FOR BORING Rock 98 %
	19. SIGNATURE OF INSPECTOR

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	10.0					
	11.0		@ 11.75: man made break.	100%		Run: 4 Begin: 9.2 End: 14.2 D.T.: 25 min. Rec: 5.05 Remarks: Picked up .85' from run 3.
	12.0					
	13.0		@ 13.1: man made break during retrieval.		Box 5	
	14.0			Run 4		
	15.0		@ 15.2: man made break.		Box 6	Run: 5 Begin: 14.2 End: 19.2 D.T.: 20 min. Rec: 4.75 Remarks: Pulled off .25'.
	16.0			100%		
	17.0		@ 17.85: man made break.			
	18.0		@ 18.35: man made break.		Box 7	
	19.0			Run 5		

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT Rehab. of Lock & Dam 2, Mon. River | HOLE NO. BR WES L-7A

Hole No. L-7A

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Lock & Dam 2	SHEET 2 OF 12 SHEETS
1. PROJECT: Rehab. of Lock & Dam 2, Mon. River		10. SIZE AND TYPE OF BIT: 4" Diamond Bit	
2. LOCATION (Coordinates or Station): See Remarks		11. DATUM FOR ELEVATION SHOWN (MSL or USL): MSL	
3. DRILLING AGENCY: USAE WES		12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500	
4. HOLE NO. (As shown on drawing title) and file number: BR WES L-7A		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0	
5. NAME OF DRILLER: Warhurst		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN: 58.9' Concrete		16. DATE HOLE: STARTED 3 Dec 85; COMPLETED	
8. DEPTH DRILLED INTO ROCK: 60.6'		17. ELEVATION TOP OF HOLE: 730.5'	
9. TOTAL DEPTH OF HOLE: 119.5'		18. TOTAL CORE RECOVERY FOR BORING: Rock 98 %	
		19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH 20.0	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	21.0		@ 20.4: man made break.			Run: 6 Begin: 19.2 End: 24.1 D.T: 25 min. Rec: 4.7 Remarks: Picked up .25' from run 5, pulled off .45' this run.
	22.0		@ 21.85: man made break.	100%	Box 8	
	23.0					
	24.0			Run 6		
	25.0		@ 24.75: man made break.		Box 9	Run: 7 Begin: 24.1 End: 28.7 D.T: 25 min. Rec: 4.9 Remarks: Picked up .45' from run 6, pulled off .15' this run.
	26.0			100%		
	27.0		@ 27.25: man made break.			
	28.0			Run 7	Box 10	
	29.0		@ 29.7: man made break.			

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: Rehab. of Lock & Dam 2, Mon. River | HOLE NO.: BR WES L-7A

Hole No. [illegible]-7A

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Lock & Dam 2	SHEET 4 OF 12 SHEETS
1. PROJECT: Rehab. of Lock & Dam 2, Mon. River		10. SIZE AND TYPE OF BIT: 5" Diamond Bit	
2. LOCATION (Coordinates or Station): See Remarks		11. DATUM FOR ELEVATION SHOWN (USGS or MSL): MSL	
3. DRILLING AGENCY: USAE WES		12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500	
4. HOLE NO. (As shown on drawing title) and file number: BR WES L-7A		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0	
5. NAME OF DRILLER: Warhurst		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN: 58.9' Concrete		16. DATE HOLE: STARTED 3 Dec 85; COMPLETED	
8. DEPTH DRILLED INTO ROCK: 60.6'		17. ELEVATION TOP OF HOLE: 730.5'	
9. TOTAL DEPTH OF HOLE: 119.5'		18. TOTAL CORE RECOVERY FOR BORING: Rock 98 %	
		19. SIGNATURE OF INSPECTOR	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	30.0					
	31		@ 30.9: man made break. @ 31.2: man made break.	100%	Box 11	Run: 8 Begin: 28.7 End: 33.5 D.T: 25 min. Rec: 4.65 Remarks: Picked up .15' from run 7, pulled off .3' this run.
	32					
	33			Run 8		
	34					Run: 9 Begin: 33.5 End: 38.3 D.T: 25 min. Rec: 4.85 Remarks: Picked up .3' from run 8, pulled off .25' this run.
	35			100%	Box 12	
	36.0		@ 35.6: man made break.			
	37.0		@ 36.5: man made break.			
	38.0		@ 37.55: man made break retrieving core from the barrel. 39.5 - 58.9: aggregate becomes siliceous with some carbonates, rounded to subrounded, scattered voids generally less than 1".	Run 9	Box 13	
	39.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: Rehab. of Lock & Dam 2, Mon. River | HOLE NO.: BR WES L-7A

Hole No. [illegible]

DRILLING LOG	DIVISION Ohio River	INSTALLATION Lock & Dam 2	SHEET 5 OF 12 SHEETS
1. PROJECT Rehab. of Lock & Dam 2, Mon. River		10. SIZE AND TYPE OF BIT 3" Diamond Bit	
2. LOCATION (Coordinates or Station) See Remarks		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY USAE WES		12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500	
4. HOLE NO. (As shown on drawing title and file number) BR WES L-7A		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 0	UNDISTURBED 0
5. NAME OF DRILLER Warhurst		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN 38.9' Concrete		16. DATE HOLE STARTED 3 Dec 85	COMPLETED
8. DEPTH DRILLED INTO ROCK 60.6'		17. ELEVATION TOP OF HOLE 730.5'	
9. TOTAL DEPTH OF HOLE 119.5'		18. TOTAL CORE RECOVERY FOR BORING Rock 98 %	
		19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH 40.0	LEGEND c	CLASSIFICATION OF MATERIALS (Descriptions) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	41			100%	Box 14	Run: 10 Begin: 36.3 End: 43.1 D.T: 25 min. Rec: 5.05 Remarks: Picked up .25' from run 9, hole is clean. Drill action became rough near 39.5' - probably due to the change in aggregate.
	42					
			@ 42.4: man made break retrieving core from barrel.			
	43			Run 10		
	44				Box 15	Run: 11 Begin: 43.1 End: 48.0 D.T: 35 min. Rec: 4.8 Remarks: Pulled off .1'.
	45		@ 45.0: horizontal fracture - possibly due to rough drill action.	100%		
	46					
			@ 46.5: man made break.			
	47		@ 47.1: man made break retrieving core from barrel.			
	48			Run 11	Box 16	
	49					
			@ 49.6: man made break retrieving core from barrel.			

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT Rehab. of Lock & Dam 2, Mon. River | HOLE NO. BR WES L-7A

Hole No. [illegible]

DRILLING LOG	DIVISION [illegible] River	INSTALLATION [illegible] Lock & Dam 2	SHEET 6 OF 12 SHEETS

1. PROJECT: Rehab. of Lock & Dam 2, Mon. River	10. SIZE AND TYPE OF BIT: 6" Diamond Bit
2. LOCATION (Coordinates or Station): See Remarks	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: USAE WES	12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500
4. HOLE NO. (As shown on drawing title) and file number): BR WES L-7A	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0
5. NAME OF DRILLER: Warhurst	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN: 38.9' Concrete	16. DATE HOLE: STARTED 3 Dec 85; COMPLETED
8. DEPTH DRILLED INTO ROCK: 60.6'	17. ELEVATION TOP OF HOLE: 730.5'
9. TOTAL DEPTH OF HOLE: 119.5'	18. TOTAL CORE RECOVERY FOR BORING: Rock 98 %
	19. SIGNATURE OF INSPECTOR

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	50					
	51			100%	Box 17	Run: 12 Begin: 48.0 End: 52.8 D.T: 35 min. Rec: 2.55 Remarks: Picked up .1' from run 11, pulled off 2.35' this run.
	52		@ 52.0: man made break retrieving core from barrel.			
				Run 12		
	53		@ 53.15: horizontal fracture - possibly a machine break.			
	54			100%	Box 18	Run: 13 Begin: 52.8 End: 55.3 D.T: 30 min. Rec: 4.5 Remarks: Picked up 2.35' from run 12, pulled off .35' this run.
	55			Run 13		
	56			100%	Box 19	Run: 14 Begin: 55.3 End: 56.5 D.T: 30 min. Rec: 3.0 Remarks: Picked up .35' from run 13, pulled off 1.45' this run. Went back in the hole & tried to pull the rest of the core - retrieved .25', therefore leaving 1.2' in the hole.
	57		@ 56.75: 4" aggregate. 56.85 - 57.1: man made rubble getting the core out of the catcher.			
	58		@ 58.45: man made break.	Run 14		
	59		58.8: contact of concrete & claystone is intact.		Box 20 Bag 1	

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT)

PROJECT: Rehab. of Lock & Dam 2, Mon. River | HOLE NO.: BR WES L-7A

Hole No. [illegible]

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Lock & Dam No. 2, Monongahela River	SHEET 2 OF 12 SHEETS

1. PROJECT: Rehabilitation of Lock & Dam No. 2, Monongahela River
2. LOCATION (Coordinates or Station): See Remarks
3. DRILLING AGENCY: USAE WES
4. HOLE NO. (As shown on drawing title and file number): BR WES L-7A
5. NAME OF DRILLER: Warhurst
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: 58.9' concrete
8. DEPTH DRILLED INTO ROCK: 60.6'
9. TOTAL DEPTH OF HOLE: 119.5'
10. SIZE AND TYPE OF BIT: 4" X 7-3/4"
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: 40
15. ELEVATION GROUND WATER: ____
16. DATE HOLE: STARTED ? Dec 85; COMPLETED
17. ELEVATION TOP OF HOLE: 730.5'
18. TOTAL CORE RECOVERY FOR BORING: Rock 98 %
19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	60.0		58.9-64.5: Clay Shale: Weathered gray w/occ red, thinly bedded, soft, becoming soft to moderately hard @ 62.7', dense, flat bedding solid, silty to very silty highly fractured w/slick-en-sides.		Bag 1	Run: 15 Begin: 58.3' End: 61.8' D.T.: 2 hr Rec.: 3.8 Remarks: Taped hole to 60.9'. Drill action was smooth in clay shale.
	61.0					
	62.0		58.9-62.7: Essentially rubble due to separation of bedding planes, occ. gravel size siltstone (2").			
			62.3-62.7': Many open fractures-essentially rubble.			Run: 16 62.7' Begin: 61.8'
	63.0		@ 62.7': Open Hi ∠ fracture @ 63.3': Open Horizontal fracture.		20	End: 65.5' D.T.: 2 hr 30 min Rec: 3.6 Remarks: Taped hole to 64.5'.
			@ 63.5': Well healed silt-stone filled frac-ture.			
	64.0		@ 63.9': Well healed silt-stone filled frac-ture.			
			@ 64.15': Open horizontal fracture after reaching surface.			64.5'
	65.0		64.5': Silty Shale: Weathered gray with very little red, thinly bedded, moderately hard to hard, flat bedding gen. solid, highly frac-tured (3" sp) with gouges (gen. silt filled), slick-en-sides.		Carton 1	65.5' Run: 17 Begin: 65.5' End: 69.3' D.T.: 2 hr 10 min Rec: 4.0 Remarks: Taped hole to 68.5'.
	66.0					
	67.0		64.5-65.5': Rubble: As a result of cutting over the core w/ the core bbl., occ. silt-stone gravels (2").			
			65.5-68.5': Many fractures, well healed and open, 2-3" sp., open fractures as follows:		21	
	68.0		@ 65.5': Hi ∠ @ 66.1': Horizontal w/a few fractures just above. @ 67.35': Horizontal			68.5'
	69.0					
	70.0					

ENG FORM 1836 MAR 71 — PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: Rehabilitation of Locks & Dam No. 2, Monongahela River — HOLE NO. L-7A

Hole No. L-7A

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Locks & Dam No. 2, Monongahela River	SHEET 8 OF 12 SHEETS

1. PROJECT: Rehabilitation of Lock & Dam No. 2, Monongahela River	10. SIZE AND TYPE OF BIT: 5" X 7-3/4"
2. LOCATION (Coordinates or Station): See Remarks	11. DATUM FOR ELEVATION SHOWN (USGS or MSL): MSL
3. DRILLING AGENCY: USAE WES	12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500
4. HOLE NO. (As shown on drawing title) and file number: BR WES L-7A	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0
5. NAME OF DRILLER: Warhurst	14. TOTAL NUMBER CORE BOXES: 40
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: ---
7. THICKNESS OF OVERBURDEN: 58.9' concrete	16. DATE HOLE: STARTED 3 Dec 85; COMPLETED
8. DEPTH DRILLED INTO ROCK: 60.6'	17. ELEVATION TOP OF HOLE: 730.5'
9. TOTAL DEPTH OF HOLE: 119.5'	18. TOTAL CORE RECOVERY FOR BORING: Rock 98 %
	19. SIGNATURE OF INSPECTOR

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	70.0		68.5-69.2': 1 side of vertical fracture is rubble due to cutting over core. @ 69.2': Machine break. @ 69.55': Horizontal fracture. @ 69.7-69.9': Irregular well healed fracture. @ 70.2-70.6': Well healed vertical fracture. @ 71.5': Irregular well healed fracture.		22	Run: 18 Begin: 69.3' End: 73.3' D.T.: 1 hr 50 min Rec.: 4.2 Remarks: Taped hole to 72.7'.
	71.0					71.4 Drill action became rough near 71.5'.
	72.0					
	73.0		@ 73.1': Machine break.		23	Run: 19 Begin: 73.3' End: 77.5' D.T.: 1 hr Rec.: 5.0 Remarks: Taped
	74.0					
	75.0		@ 74.55: Machine break.			74.55 hole to 77.1'.
	76.0		@ 75.7': Machine break. 75.7': Well healed verrical fracture.		24	
	77.0		@ 76.6': MMB			77.1
	78.0		@ 78.3': Open horizontal fracture. Probably a machine break.		25	Run: 20 Begin: 77.5' End: 81.7' D.T.: 1 hr Rec.: 4.1 Remarks: Taped hole to 81.2'.
	79.0		@ 78.95': Open horizontal fracture. Probably a machine break.			
	80.0					

Hole No. L-7A

DRILLING LOG	Division: Ohio River	Installation: Monongahela River	Sheet: 9 of 12 sheets
1. Project: Rehabilitation of Lock & Dam No. 2, Monongahela River		10. Size and type of bit: 3" X 7-3/4"	
2. Location (Coordinates or Station): See Remarks		11. Datum for elevation shown (TBM or MSL): MSL	
3. Drilling agency: USAE WES		12. Manufacturer's designation of drill: Failing 1500	
4. Hole no. (As shown on drawing title) and file number: BR WES L-7A		13. Total no. of overburden samples taken: Disturbed 0; Undisturbed 0	
5. Name of driller: Warhurst		14. Total number core boxes: 40	
6. Direction of hole: ☒ Vertical ☐ Inclined ____ deg. from vert.		15. Elevation ground water: ——	
7. Thickness of overburden: 58.9' concrete		16. Date hole: Started 3 Dec 85; Completed	
8. Depth drilled into rock: 60.6'		17. Elevation top of hole: 730.5'	
9. Total depth of hole: 119.5'		18. Total core recovery for boring: Rock 98 %	
		19. Signature of inspector	

Elevation	Depth	Legend	Classification of Materials (Description)	% Core Recovery	Box or Sample No.	Remarks (Drilling time, water loss, depth of weathering, etc., if significant)
	80.0		@ 80.1' - MB			
	81.0				26	
	82.0		82.1' - MB			Run: 21 Begin: 81.7' End: 85.9' D.T.: 1 hr 20 min
	83.0		@ 83.0 - MB			83.0' Rec.: 4.0 Remarks: Taped hole to 85.3'.
	84.0		@ 83.8' - MMB Removing catcher.		27	
	85.0					85.3'
	86.0		86.2-86.6': Machine cut over this part of core. 86.6-89.3': Well healed vertical fracture.			86.0' Run: 22 Begin: 85.9' End: 90.1' D.T.: 1 hr 15 min Rec.: 3.3 Remarks: Taped hole to 89.3'.
	87.0					
	88.0		@ 87.7' - MB 87.7-87.9': Low ∠ well healed fracture. 88.4-88.7': Hi ∠ well healed fracture.		28	
	89.0		@ 89.3' slick at bottom of recovery. Broken from going over the core with the barrel.			89.3'
	90.0				29	

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

Project: Rehabilitation of Locks & Dam No. 2, Monongahela River | Hole No. L-7A

Hole No. L-7A

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Monongahela River	SHEET 10 OF 12 SHEETS
1. PROJECT: Rehabilitation of Lock & Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT: 5" X 7-3/4"	
2. LOCATION (Coordinates or Station): See Remarks		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL	
3. DRILLING AGENCY: USAE WES		12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500	
4. HOLE NO. (As shown on drawing title) and file number: BR WES L-7A		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0	
5. NAME OF DRILLER: Warhurst		14. TOTAL NUMBER CORE BOXES: 40	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER: ---	
7. THICKNESS OF OVERBURDEN: 8.9' concrete		16. DATE HOLE: STARTED 3 Dec 85; COMPLETED	
8. DEPTH DRILLED INTO ROCK: 90.6		17. ELEVATION TOP OF HOLE: 730.5'	
9. TOTAL DEPTH OF HOLE: 119.5'		18. TOTAL CORE RECOVERY FOR BORING Rock 98 %	
		19. SIGNATURE OF INSPECTOR	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	90.0		@ 90.05': Open low ∠ fracture with slick.			90.5 Run: 23 Begin: 90.1 End: 93.6' D.T.: 1 hr 40 min Rec.: 3.6 Remarks: Taped hole to 92.05'.
	91.0		90.5-91.0': Open Hi ∠ fracture w/slick.		30	
	92.0		92.05-95.7': Well healed joint. Still moderately hard to hard gray.			
	93.0		@ 93.1': Open horizontal fracture w/slick. Probably a machine break.			93.1'
	94.0		@ 94.4': Open horizontal fracture w/slick. Probably a machine break.		31	Run: 24 Begin: 93.6' End: 96.8' D.T.: 1 hr Rec.: 3.65 Remarks: Taped hole to 95.7'.
	95.0					95.7'
	96.0		@ 96.65': Open horizontal fracture w/slick. Probably a machine break.			
	97.0		@ 96.65-97.1': Core is chipped from a machine break.		32	
	98.0		@ 97.4': Well healed Hi ∠ fracture.			
			@ 97.95: Open horizontal fracture. Probably a machine break.			
	99.0		98.9-99.3': Open Hi ∠ fracture w/slick.			99.0'
			99.5-99.8': Open Hi ∠ fracture w/slick.			
	100.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT)

PROJECT: Rehabilitation of Locks & Dam No. 2, Monongahela River | HOLE NO. L-7A

Hole No. L-7A

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Monongahela River	SHEET 11 OF 12 SHEETS
1. PROJECT: Rehabilitation of Lock & Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT: 6" X 7-3/4"	
2. LOCATION (Coordinates or Station): See Remarks		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL	
3. DRILLING AGENCY: USAE WES		12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500	
4. HOLE NO. (As shown on drawing title) and file number: BR WES L-7A		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0	
5. NAME OF DRILLER: Warhurst		14. TOTAL NUMBER CORE BOXES: 40	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER: ---	
7. THICKNESS OF OVERBURDEN: 58.9' concrete		16. DATE HOLE: STARTED 1 Dec 85; COMPLETED	
8. DEPTH DRILLED INTO ROCK: 60.6'		17. ELEVATION TOP OF HOLE: 730.5'	
9. TOTAL DEPTH OF HOLE: 119.5'		18. TOTAL CORE RECOVERY FOR BORING: Rock 98 %	
		19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	100.0		99.9-100.2': Hi ∠ open fracture w/slick.		33	Run: 25 Begin: 96.8' End: 100.6' D.T.: 1 hr 10 min Rec: 4.45 Remarks: Taped
	101.0		100.4-100.8': Hi ∠ open fracture w/slick.			101.3' hole to 100.15'
			100.9-101.3': Hi ∠ open fracture w/slick.			
	102.0		101.9-102.3': Hi ∠ open fracture w/slick.		34	Run: 26 Begin: 100.6' End: 104.7' D.T.: 1 hr Rec: 3.15
	103.0		102.5-102.8': Hi ∠ open fracture w/slick.			103.3'
			102.8-103.3': Becomes harder w/silty pockets or gouges.			
	104.0		103.3-107.2': Clay shale: Weathered, highly fractured space generally 4-6", gray becoming red near 106.0', soft, gravel size silt, stone filled gouges, thinly bedded, flat bedding, very silty.			
	105.0				35	
	106.0		103.3-103.6': fractured rubble.			Run: 27 Begin: 104.7' 105.8' End: 109.0 D.T.: 2 hr Rec: 3.7 Remarks: Taped
		Partially healed Fracture	@ 105.8 low open fracture.			hole to 107.2'.
			@ 106.5-106.8': Low open fracture w/slick.		36	
	107.0		107.2-111.0': Clay shale: gray, weathered, fractured, moderately hard, thinly bedded, flat bedding, solid dense.			107.2'
	108.0		107.2-107.9': Fractured to a rubble; went over with core barrel.		37	
	109.0		@ 107.9': Open horizontal fracture.			
			@ 109.5': Open horizontal fracture.			
	110.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT)

PROJECT: Rehabilitation of Locks & Dam No. 2, Monongahela River | HOLE NO. L-7A

Hole No. L-7A

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Monongahela River	SHEET 12 OF 14 SHEETS
1. PROJECT: Rehabilitation of Lock & Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT: 6" X 7-3/4"	
2. LOCATION (Coordinates or Station): See Remarks		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL	
3. DRILLING AGENCY: USAE WES		12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500	
4. HOLE NO. (As shown on drawing title) and file number: BR WES L-7A		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0	
5. NAME OF DRILLER: Warhurst		14. TOTAL NUMBER CORE BOXES: 40	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER: —	
7. THICKNESS OF OVERBURDEN: 58.9' concrete		16. DATE HOLE: STARTED 5 Dec 85; COMPLETED	
8. DEPTH DRILLED INTO ROCK: 60.6'		17. ELEVATION TOP OF HOLE: 730.5'	
9. TOTAL DEPTH OF HOLE: 119.5'		18. TOTAL CORE RECOVERY FOR BORING: Rock 98 %	
		19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	110.0		110.4-110.5': Fractured to a rubble. @ 110.5' open horizontal fracture.		38	Run: 28 Begin: 108.0' 110.5' End: 112.0' D.T.: 2 hr 10 min Rec: 3.8'
	111.0		111.0-113.9': Clay shale: Red with some gray, sort, weathered, highly fractured with some slicks, thinly bedded. flat bedding, dense, solid		carton 2	111.0' Remarks: Taped hole to 111.0'.
	112.0		111.0-112.0': Rubble due to drilling over. @ 112.0' open horizontal fracture.			112.0'
	113.0		112.1-112.25': open low angle fractures. @ 113.2' open horizontal fractures. @ 113.65' open fracture with slick.		38	Run: 29 Begin: 112.0' End: 115.8' D.T.: 2 hr Rec.: 2.9' Remarks: Taped hole to 113.9'.
	114.0		113.65-113.9': fractured to a rubble.		Bag 4	113.65'
					Bag 5	113.9'
			113.9-117.0': Clay shale: Highly fractured, weathered, soft, mottled, flat bedding, thinly bedded, solid, dense.		Bag 6	114.3'
					Bag 7	114.6'
	115.0		113.9-114.8': rubble due to drilling over. 114.8-115.1': low angle partially healed fracture.		39	
	116.0		@ 115.6' open horizontal fracture. 116.6-117.0': highly fractured to a rubble.			Run: 30 Begin: 115.8' End: 118.0' 116.6' D.T.: 3 hr Rec: 3.1'
					Bag 8	Remarks: Taped hole to 117.0'. Water color changed to pale red at 117.4'.
	117.0		117.0-119.5': Clay shale: Highly fractured, weathered, soft, mottled, flat bedding, thinly bedded, dense, solid.			117.0'
	118.0		@ 117.6' low angle open fracture. @ 117.8' low angle open fracture. 117.8-117.9' fractured to a rubble.		40	Run: 31 Begin: 118.0' End: 120.7' D.T.: 1 hr 30 min Rec.: 2.5' Remarks: Taped hole to 120.7'.
	119.0		117.9-118.2' high angle open fracture. 118.4-118.8' clay filled low angle fracture. @ 119.2' low angle open fracture with slick.			119.5'
	120.0		@ 119.5' E.O.B.			

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT)

PROJECT: Rehabilitation of Locks & Dam No. 2, Monongahela River | HOLE NO. L-7A

Hole No. --

DRILLING LOG	DIVISION Ohio River	INSTALLATION Lock & Dam #2	SHEET 1 OF 2 SHEETS
1. PROJECT: Rehab. of Lock & Dam 2, Mon. River		10. SIZE AND TYPE OF BIT: [illegible] Diamond	
2. LOCATION (Coordinates or Station): See Remarks		11. DATUM FOR ELEVATION SHOWN (MSL): USL	
3. DRILLING AGENCY: USAE-WES		12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500	
4. HOLE NO. (As shown on drawing title and file number): BR WES L-9		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 0	UNDISTURBED 0
5. NAME OF DRILLER: Warnurst		14. TOTAL NUMBER CORE BOXES: 4	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER: n/a	
7. THICKNESS OF OVERBURDEN: 0.0		16. DATE HOLE: STARTED 12 Dec 85	COMPLETED 18 Dec 85
8. DEPTH DRILLED INTO ROCK: 9.5		17. ELEVATION TOP OF HOLE: [illegible]	
9. TOTAL DEPTH OF HOLE: 10.65' in Concrete		18. TOTAL CORE RECOVERY FOR BORING: 100%	
		19. SIGNATURE OF INSPECTOR: [signature]	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	0.0		Surface Condition: slightly weathered with light scaling. Maximum exposed aggregate size is ¾". Hole is located on a surface crack - note to what depth it extends. 0.0 - 10.0 Concrete: gray, predominately crushed limestone aggregate, subangular to angular, has entrained air, has entrapped air, many voids generally less than ¼" diameter & deep, some aggregate are cracked, 0.0 - 1.5: maximum aggregate size is ¾". 1.5 - 10.0: maximum aggregate size is 3". 0.0 - 2.85: vertical crack in core - becomes open @ 2.2'. 2.4 - 2.9: incipient vertical crack. @ 3.75: copper wire in core. @ 5.75: man made break.			
	1.0			100%	Box 1	Run: 1 Begin: 0.0 End: 2.2 D.T: 15 min. Rec: 2.2 Remarks: Started hole with a thin-walled diamond bit.
	2.0			Run 1		
	3.0					Run: 2 Begin: 2.2 End: 7.15 D.T: 50 min. Rec: 4.95 Remarks: --
	4.0				Box 2	
	5.0			100%		
	6.0				Box 3	
	7.0			Run 2		
	8.0				Box 4	Run: 3 Begin: 7.15 End: 10.65 D.T: 55 min. Rec: 2.85 Remarks: Pulled off .05'.
	9.0			100%		ABBREVIATIONS: D.T: drill time Rec: recovery E.O.B: end of boring.

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PROJECT Rehab. of Lock & Dam 2, Mon. River | HOLE NO. BR WES L-9

Hole No. BR WES L-9

DRILLING LOG	DIVISION Ohio River	INSTALLATION Lock & Dam 2	SHEET 2 OF 2 SHEETS
1. PROJECT Rehab. of Lock & Dam 2, Mon. River		10. SIZE AND TYPE OF BIT 6" Diamond	
2. LOCATION (Coordinates or Station) See Remarks		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY USAE WES		12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500	
4. HOLE NO. (As shown on drawing title) and file number BR WES L-9		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 0	UNDISTURBED 0
5. NAME OF DRILLER Warhurst		14. TOTAL NUMBER CORE BOXES 4	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER n/a	
		16. DATE HOLE STARTED 18 Dec 85	COMPLETED 18 Dec 85
7. THICKNESS OF OVERBURDEN 0.0		17. ELEVATION TOP OF HOLE 730.5'	
8. DEPTH DRILLED INTO ROCK 0.0		18. TOTAL CORE RECOVERY FOR BORING 100 %	
9. TOTAL DEPTH OF HOLE 10.65' in Concrete		19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH 10.0	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	10.65		E.O.B. @ 10.65	Run 3		LOCATION: 1110N0 66 LANDWALL 5' 11.8' RIVER FLOW 810N0. 67

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT)

PROJECT Rehab. of Lock & Dam 2, Mon. River | HOLE NO. BR WES L-9

Hole No. -

DRILLING LOG	DIVISION Ohio River	INSTALLATION Lock & Dam 2	SHEET 1 OF 10 SHEETS
1. PROJECT Renab. of Lock & Dam 2, Mon. River		10. SIZE AND TYPE OF BIT [illegible]	
2. LOCATION (Coordinates or Station) See Remarks		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY Sprague & Henwood		12. MANUFACTURER'S DESIGNATION OF DRILL Failing, Model 4750A, Skid Rig	
4. HOLE NO. (As shown on drawing title) and file number	BR WB3 M-1	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 3 / UNDISTURBED 0
5. NAME OF DRILLER Dan Taylor		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN Concrete 0.3		16. DATE HOLE STARTED 16 Dec 85 / COMPLETED 17 Dec 85	
8. DEPTH DRILLED INTO ROCK 9.5		17. ELEVATION TOP OF HOLE [illegible]	
9. TOTAL DEPTH OF HOLE 9.8		18. TOTAL CORE RECOVERY FOR BORING Rock 98 %	
		19. SIGNATURE OF INSPECTOR Lloyd M. Duty	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	0.3		Surface Condition: slightly weathered with light scaling. Maximum exposed aggregate size is 2".			Run: 1 Begin: 0.0 End: 2.3 D.T: 45 min. Rec: 2.3 Remarks: --
	1.0		0.0 - Concrete: grav, siliceous with occasional carbonates, maximum aggregate size is 3", river gravel, subrounded to subangular, good consolidation, has entrained air, no entrained air, scattered voids generally less than ¼" diameter & deep, @ 1.0: man made break retrieving core. 1.0 - 1.2: man made chip in the side of the core.	100% Run 1	Box 1	
	2.0					
	3.0					Run: 2 Begin: 2.3 End: 4.6 D.T: 30 min. Rec: 2.3 Remarks: --
	4.0			100% Run 2	Box 2	
	5.0		4.6 - 5.7: side of core is cracked removing catcher.			Run: 3 Begin: 4.6 End: 6.6 D.T: 55 min. Rec: 2.2 Remarks: --
	6.0			100% Run 3	Box 3	
	7.0		@ 7.6: man made break			Run: 4 Begin: 6.6 End: 11.6 D.T: 1 hr 50 min Rec: 4.75 Remarks: Pulled off .25'.
	8.0					
	9.0		@ 9.8: low angle fracture with 1" steel, possibly due to drill action.	100%		

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT) | PROJECT | HOLE NO.

Hole No. -

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Lock & Dam #2	SHEET 2 OF 10 SHEETS
1. PROJECT: Rehab. of Lock & Dam 2, Mon. River		10. SIZE AND TYPE OF BIT	
2. LOCATION (Coordinates or Station)		11. DATUM FOR ELEVATION SHOWN (GS or MSL)	
3. DRILLING AGENCY		12. MANUFACTURER'S DESIGNATION OF DRILL	
4. HOLE NO. (As shown on drawing title) and file number: BR 433 H-1		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED	
5. NAME OF DRILLER		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN		16. DATE HOLE: STARTED / COMPLETED	
8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE	
9. TOTAL DEPTH OF HOLE		18. TOTAL CORE RECOVERY FOR BORING: Rock 98 %	
		19. SIGNATURE OF INSPECTOR: [illegible]	

ELEVATION a	DEPTH 10.0	LEGEND c	CLASSIFICATION OF MATERIALS (Descriptions) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	11				Box 5	
				Run 4		
	12					Run: 5 Begin: 11.8 End: 17.0 D.T: 1 hr 40 min Rec: 5.05 Remarks: Picked up .25' from run 4, pulled off .4' this run.
	13		@ 12.95: man made break.			
	14				Box 6	
	15					
	16					
	17		@ 17.2: incipient crack.	Run 5		
	18				Box 7	Run: 6 Begin: 17.0 End: 22.0 D.T: 1 hr 40 min Rec: 5.0 Remarks: Picked up .4' from run 5, pulled off .4' this run.
	19					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT | HOLE NO.

Hole No. [illegible]

DRILLING LOG	DIVISION Ohio River	INSTALLATION Lock & Dam #2	SHEET 2 OF 10 SHEETS
1. PROJECT: Rehab. of Lock & Dam 2, Mon. River		10. SIZE AND TYPE OF BIT	
2. LOCATION (Coordinates or Station)		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
3. DRILLING AGENCY		12. MANUFACTURER'S DESIGNATION OF DRILL	
4. HOLE NO. (As shown on drawing title and file number): BR WLS [illegible]-1		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED	UNDISTURBED
5. NAME OF DRILLER		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN		16. DATE HOLE: STARTED	COMPLETED
8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE	
9. TOTAL DEPTH OF HOLE		18. TOTAL CORE RECOVERY FOR BORING: Rock 98 %	
		19. SIGNATURE OF INSPECTOR: [illegible]	

ELEVATION a	DEPTH 20&3	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	21		@ 20.35: man made break.	100%		
	22			Run 6	Box 6	Run: 7 Begin: 22.0 End: 27.0 D.T: 1 hr Rec: 4.5 Remarks: Picked up .4' from run 6, pulled off .3' this run.
	23		@ 23.05: man made break. @ 23.45: ¼" steel. @ 23.65: man made break.			
	24		@ 24.6: 1" steel.	100%		
	25				Box 9	
	26		@ 26.3: man made break.			
	27			Run 7		
	28		@ 27.15: man made break.			
	29			100%		

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT

HOLE NO.

Hole No. -

DRILLING LOG	DIVISION Ohio River	INSTALLATION Lock & Dam #2	SHEET 2 OF 10 SHEETS
1. PROJECT Rehab. of Lock & Dam 2, Mon. River		10. SIZE AND TYPE OF BIT	
2. LOCATION (Coordinates or Station)		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
3. DRILLING AGENCY		12. MANUFACTURER'S DESIGNATION OF DRILL	
4. HOLE NO. (As shown on drawing title) and file number	BR [illegible] M-1	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED	
5. NAME OF DRILLER		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN		16. DATE HOLE | STARTED | COMPLETED	
8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE	
9. TOTAL DEPTH OF HOLE		18. TOTAL CORE RECOVERY FOR BORING Rock 98 %	
		19. SIGNATURE OF INSPECTOR [illegible]	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	30.0					Run: 8 Begin: 27.0 End: 31.1 D.T: 1 hr 5 min Rec: 5.1 Remarks: Picked up .3' from run 7.
	31		@ 30.35: man made break.	Run 8	Box 11	
	32		@ 32.6: machine break.	100%		Run: 9 Begin: 31.1 End: 35.1 D.T: 1 hr Rec: 3.6 Remarks: Pulled off .4' this run.
	33					
	34				Box 12	
	35		@ 34.8: 1" long x ½" wide void.	Run 9		
			@ 35.5: 1" long x 3/4" wide & deep void.			Run: 10 Begin: 35.1 End: 39.9 D.T: 1 hr 10 min Rec: 5.2 Remarks: Picked up .4' from run 9.
	36		@ 35.75: machine break.			
			@ 35.9: 2" long x ½" deep void.			
			@ 36.75: man made break.			
	37		@ 37.75: man made break.	100%	Box 13	
	38					
	39		@ 38.9: man made break.	Run 10		

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT | HOLE NO.

Hole No. -

DRILLING LOG	DIVISION Ohio River	INSTALLATION Lock & Dam #2	SHEET 5 OF 10 SHEETS
1. PROJECT Rehab. of Lock & Dam 2, Mon. River		10. SIZE AND TYPE OF BIT	
2. LOCATION (Coordinates or Station)		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
3. DRILLING AGENCY		12. MANUFACTURER'S DESIGNATION OF DRILL	
4. HOLE NO. (As shown on drawing title) and file number BR WES M-1		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED	UNDISTURBED
5. NAME OF DRILLER		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
		16. DATE HOLE: STARTED	COMPLETED
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE	
8. DEPTH DRILLED INTO ROCK		18. TOTAL CORE RECOVERY FOR BORING: Rock 98 %	
9. TOTAL DEPTH OF HOLE		19. SIGNATURE OF INSPECTOR	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Descriptions)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	40.0				Box 14	Run: 11 Begin: 39.9 End: 44.95 D.T: 1 hr 50 min Rec: 5.05 Remarks: --
	41		@ 41.05: man made break.			
	42		@ 42.25: man made break.	100%		
	43				Box 15	
	44					
				Run 11		
	45		@ 45.5: 1½" long x 3/4" diameter x deep weathered out concretion.			Run: 12 Begin: 44.95 End: 49.9 D.T: 1 hr 25 min Rec: 4.0 Remarks: Pulled off .95' this run. Driller overloaded core barrel causing mechanical breaks.
	46		@ 46.5: 1" long & deep void.	100%	Box 16	
	47		@ 46.9: machine break.			
	48		@ 47.85: machine break. @ 48.35: machine break.			
	49		@ 48.95: machine break.	Run 12		

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PROJECT HOLE NO.

Hole No. M-1

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Lock & Dam No. 2	SHEET 6 OF 10 SHEETS
1. PROJECT: Rehabilitation of Lock & Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT: 6" Diamond	
2. LOCATION (Coordinates or Station): See Remarks		11. DATUM FOR ELEVATION SHOWN (USM or MSL): MSL	
3. DRILLING AGENCY: USAE-WES		12. MANUFACTURER'S DESIGNATION OF DRILL: Failing, Model 43-6A, Skid Rig	
4. HOLE NO. (As shown on drawing title and file number): BR WES M-1		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 0	UNDISTURBED 0
5. NAME OF DRILLER: Dan Taylor		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
		16. DATE HOLE: STARTED 6 Dec 85	COMPLETED 17 Dec 85
7. THICKNESS OF OVERBURDEN: Concrete 60.35		17. ELEVATION TOP OF HOLE: 732.5'	
8. DEPTH DRILLED INTO ROCK: 36.75		18. TOTAL CORE RECOVERY FOR BORING: Rock 98 %	
9. TOTAL DEPTH OF HOLE: 97.1'		19. SIGNATURE OF INSPECTOR: Hershel McGinty	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	50.0		@ 50.1: machine break.		Box 17	Run: 13 Begin: 49.9 End: 54.0 D.T.: 2 hrs Rec: 5.05 Remarks: Picked up .95' from run 12. Driller overloaded core barrel causing mechanical breaks.
	51.0		@ 51.35: machine break. @ 51.95: machine break. @ 52.3: machine break.			
	52.0		@ 52.6: machine break. @ 53.0: machine break. @ 53.35: machine break.		Box 18	
	53.0					
	54.0			Run 13		
	55.0		@ 55.05: machine break.		Box 19	Run: 14 Begin: 54.0 End: 58.9 D.T.: 2 hr 25 min Rec: 4.9' Loss: 0.0'
	56.0					
	57.0		@ 57.20: machine break.			
	58.0		@ 57.7: machine break.			
	59.0			Run 14	Box 20	
	60.0					

Hole No. M-1

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Lock & Dam No. 2	SHEET 7 OF 10 SHEETS
1. PROJECT: Rehabilitation of Lock & Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT: 6" Diamond	
2. LOCATION: See Remarks		11. DATUM FOR ELEVATION SHOWN: MSL	
3. DRILLING AGENCY: USAE-WES		12. MANUFACTURER'S DESIGNATION OF DRILL: Failing, Model 43-6A, Skid Rig	
4. HOLE NO.: BR WES M-1		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0	
5. NAME OF DRILLER: Dan Taylor		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN: Concrete 60.35		16. DATE HOLE: STARTED 6 Dec 85; COMPLETED 17 Dec 85	
8. DEPTH DRILLED INTO ROCK: 36.75		17. ELEVATION TOP OF HOLE: 732.5'	
9. TOTAL DEPTH OF HOLE: 97.1'		18. TOTAL CORE RECOVERY FOR BORING: Rock 98 %	
		19. SIGNATURE OF INSPECTOR: Hershel McGinty	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	60.0		Concrete-rock contact, low angle break.			@ 60.35' concrete-rock contact.
	61.0		Clay shale, light gray, soft to moderately hard. @ 61.1' - horizontal fracture w/brown staining. @ 60.7-61.1 - vertical fracture. @ 62.15-62.3 - tract ofcoal. @ 62.7 - horizontal fracture.		Box 21	Run: 15 Begin: 60.35 End: 63.65 D.T.: 1 hr 45 min Rec: 3.15'
	62.0					
	63.0			Run 15		
			Rubble			
	64.0					Run: 16 Begin: 63.65 End: 67.4 D.T.: 2 hr 15 min Rec: 2.50' Loss: 1.55'
	65.0		Horizontal fracture.		Box 22	
	66.0			Run 16		
			Overcored - numerous horizontal fractures, spaced 1-2" apart.			Run: 17 Begin: 67.4 End: 69.4 D.T.: 1 hr 20 min Rec: 3.75' Gain: 1.55'
	67.0					
	68.0		Horizontal fracture.			
			Horizontal fracture. Clay shale, brown, soft to moderately hard. Horizontal fractures.		Box 23	
	69.0		Rubble	Run 17		
			Rubble			
	70.0					

ENG FORM 1836 MAR 71 — PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: Rehabilitation of Lock & Dam No. 2, Monongahela River — HOLE NO. M-1

Hole No.

DRILLING LOG

DIVISION: Ohio River	INSTALLATION: Lock & Dam #2
SHEET 8 OF 10 SHEETS	
1. PROJECT: Rehab of Lock & Dam 2, Mon. River	10. SIZE AND TYPE OF BIT: 6" Diamond
2. LOCATION (Coordinates or Station): See Remarks	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: USAE WES	12. MANUFACTURER'S DESIGNATION OF DRILL: Failing, Model 43-6A, Skid Rig
4. HOLE NO. (As shown on drawing title) and file number: BR WES M-1	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0
5. NAME OF DRILLER: Dan Taylor	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN: Concrete 60.35'	16. DATE HOLE: STARTED 6 Dec 85; COMPLETED 7 Dec 85
8. DEPTH DRILLED INTO ROCK: 36.75'	17. ELEVATION TOP OF HOLE: 732.5'
9. TOTAL DEPTH OF HOLE: 97.1'	18. TOTAL CORE RECOVERY FOR BORING: Rock 98 %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Horizontal fracture		27	
	81.0		Horizontal fracture			Run: 20 Begin: 79.1 End: 83.7 D.T.: 1 hr 30 min Rec: 5.1' Gain: 0.1'
			Horizontal fracture			
	82.0				Box 28	
			Horizontal fracture			
	83.0		Horizontal fracture			
			Horizontal fracture	Run 20		
	84.0					
	85.0		Horizontal fracture		Box 29	Run: 21 Begin: 83.7 End: 88.7 D.T.: 1 hr 40 min Rec: 4.9' Loss: 0.1'
	86.0		Horizontal fracture			
	87.0		Horizontal fracture			
	88.0		Horizontal fracture		Box 30	
			Horizontal fracture	Run 21		
	89.0		Horizontal fracture Clay shale, red and gray			
	90.0					

Hole No.

DRILLING LOG	Division: Ohio River	Installation: Lock & Dam #2	Sheet 9 of 10 Sheets
1. Project: Rehab. of Lock & Dam 2, Mon. River		10. Size and Type of Bit: " Diamond	
2. Location (Coordinates or Station): See Remarks		11. Datum for Elevation Shown (MSL or USC&GS): MSL	
3. Drilling Agency: USAE WES		12. Manufacturer's Designation of Drill: Failing, Model 43-6A, Skid Rig	
4. Hole No. (As shown on drawing title) and file number: BR WES M-1		13. Total No. of Overburden Samples Taken: Disturbed 0; Undisturbed 0	
5. Name of Driller: Dan Taylor		14. Total Number Core Boxes	
6. Direction of Hole: ☒ Vertical ☐ Inclined ____ Deg. from Vert.		15. Elevation Ground Water	
7. Thickness of Overburden: Concrete 0.35'		16. Date Hole: Started 6 Dec 85; Completed 7 Dec 85	
8. Depth Drilled into Rock: 36.75'		17. Elevation Top of Hole: 732.5'	
9. Total Depth of Hole: 97.1'		18. Total Core Recovery for Boring: Rock 98 %	
		19. Signature of Inspector	

Elevation a	Depth b	Legend c	Classification of Materials (Descriptions) d	% Core Recovery e	Box or Sample No. f	Remarks (Drilling time, water loss, depth of weathering, etc., if significant) g
	71.0		Horizontal Fractures		Box 24	Run: 18 Begin: 69.4 End: 74.5 D.T.: 2 hr 10 min Rec: 5.0' Loss: 0.0' Comments: Core froze during wrapping
			Clay shale, brown and gray, soft to moderately hard			
	72.0		Low angle fracture			
			Low angle fracture			
			Clay shale, gray			
	73.0					
	74.0		Horizontal fractures	Run 18	Box 25	
	75.0		Horizontal fracture			
	76.0		Horizontal fracture			
	77.0		Horizontal fracture		Box 26	Run: 19 Begin: 74.5 End: 79.1 D.T.: 1 hr 30 min Rec: 4.6' Loss: 0.0'
	78.0		Horizontal fracture			
	79.0		Slipped over	Run 19		
			Horizontal fracture			
	80.0				Box	

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Project: Rehab of Lock & Dam 2, Mon. River — Hole No.: BR WES M-1

Hole No. M-1

DRILLING LOG	DIVISION Ohio River	INSTALLATION Lock & Dam No. 2	SHEET 10 OF 10 SHEETS
1. PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT [illegible]" Diamond	
2. LOCATION (Coordinates or station) See Remarks		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY USAE-WES		12. MANUFACTURER'S DESIGNATION OF DRILL Failing, Model 43-6A, Skid Rig	
4. HOLE NO. (As shown on drawing title) and file number BR WES M-1		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 0	UNDISTURBED 0
5. NAME OF DRILLER Dan Taylor		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
		16. DATE HOLE STARTED 16 Dec 85	COMPLETED 17 Dec 85
7. THICKNESS OF OVERBURDEN Concrete 0.35		17. ELEVATION TOP OF HOLE 732.5'	
8. DEPTH DRILLED INTO ROCK 96.75		18. TOTAL CORE RECOVERY FOR BORING Rock 98 %	
9. TOTAL DEPTH OF HOLE 97.1'		19. SIGNATURE OF INSPECTOR Hershel McGinty	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc. if significant) g
			Horizontal fracture.			
	91.0				Box 31	Run: 22 Begin: 88.7 End: 93.7 D.T.: 1 hr 50 min Rec: 4.35' Loss: 0.65'
			Horizontal fracture.			
	92.0					
			Horizontal fracture.			
	93.0			Run 22		
			Horizontal fracture.			
			Horizontal fracture.			
	94.0					Run: 23 Begin: 93.7 End: 97.1 D.T.: 1 hr 4[illegible] min Rec: 3.25' Loss: 0.15'
			Horizontal fracture.			
	95.0				Box 32	
			Horizontal fracture.			
	96.0					
	97.0		E.O.B. @ 97.1	Run 23		
	98.0					ABBREVIATIONS: H.F.: Horizontal Fracture D.T.: Drill Time Rec.: Recovery E.O.B.: End of Boring
	99.0					
	100.0					

ENG FORM 1836 MAR 71 — PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT)

PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River — HOLE NO. M-1

Hole No. -

DRILLING LOG	DIVISION: Mid River	INSTALLATION: Lock & Dam 2	SHEET: OF 1 SHEETS
1. PROJECT: Rehab. of Lock & Dam 2, Mon. River		10. SIZE AND TYPE OF BIT: [illegible]	
2. LOCATION (Coordinates or Station): See Remarks		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL	
3. DRILLING AGENCY: USAE-WES		12. MANUFACTURER'S DESIGNATION OF DRILL: MOR-12, Series A-100, 110 volt	
4. HOLE NO. (As shown on drawing title) and file number: BR WES M-2		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 1; UNDISTURBED 0	
5. NAME OF DRILLER: Dan Taylor		14. TOTAL NUMBER CORE BOXES: -	
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED 90 DEG. FROM VERT. horizontal		15. ELEVATION GROUND WATER: [illegible]	
7. THICKNESS OF OVERBURDEN: 0.0		16. DATE HOLE: STARTED 22 Oct 85; COMPLETED 22 Oct 85	
8. DEPTH DRILLED INTO ROCK: 3.2		17. ELEVATION TOP OF HOLE: [illegible]	
9. TOTAL DEPTH OF HOLE: 3.2' in Concrete		18. TOTAL CORE RECOVERY FOR BORING: 100 %	
		19. SIGNATURE OF INSPECTOR: [illegible]	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	0.0		Surface Condition: badly weathered with exposed agg. - max. agg. size is 4".	100%		Run: 1 Begin: 0.0 End: 1.15 D.T.: 25 min. Rec: 1.15 Remarks: -
	1.0		0.0 - 3.15 Concrete: gray, siliceous with some carbonates, max. agg. size is 1", river gravel, surrounded to subangular, good consolidation, entrapped air, entrained air, many voids - none greater than ¼" diameter & deep unless noted, @ .1: manmade break during retrieval. @ .7: manmade break during retrieval. @ 1.6: 1" long void.	Run 1		
	2.0			100%	Box 1	Run: 2 Begin: 1.15 End: 3.2 D.T.: 2 hrs 5 min. Rec: 2.0 Remarks: Pulled off .05' this run. Drill action was smooth throughout boring. 100% of water was retained.
	3.0			Run 2		
			E.O.B. = 3.2'			ABBREVIATIONS: agg: aggregate max: maximum D.T.: drill time Rec: recovery E.O.B.: end of boring. LOCATION: [illegible] mono mono. [illegible] 10 13.4' LARGE CHAMBER —flow →
						LANDWALL

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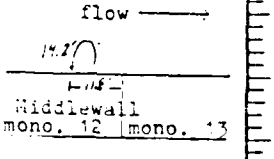
PROJECT: Rehab. of Lock & Dam 2, Mon. River | HOLE NO.: BR WES M-2

Hole No. BR WES M-3

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Lock & Dam #2	SHEET 1 OF 1 SHEETS
1. PROJECT: Rehab. of Lock & Dam 2, Mon. River		10. SIZE AND TYPE OF BIT: [illegible]	
2. LOCATION (Coordinates or Station): See Remarks		11. DATUM FOR ELEVATION SHOWN (USGS or ASK): USE	
3. DRILLING AGENCY: USAE-WES		12. MANUFACTURER'S DESIGNATION OF DRILL: ACKER-II, Series A-100, 110 volt	
4. HOLE NO. (As shown on drawing title and file number): BR WES M-3		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 0	UNDISTURBED 0
5. NAME OF DRILLER: Dan Taylor		14. TOTAL NUMBER CORE BOXES:	
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED 20 DEG. FROM VERT. Horizontal		15. ELEVATION GROUND WATER: N/A	
7. THICKNESS OF OVERBURDEN: 3.0		16. DATE HOLE: STARTED 23 Oct 85 COMPLETED 27 Oct 85	
8. DEPTH DRILLED INTO ROCK: 3.0		17. ELEVATION TOP OF HOLE: [illegible]	
9. TOTAL DEPTH OF HOLE: 7.15' 1 hrs 3 minute		18. TOTAL CORE RECOVERY FOR BORING: 100%	
		19. SIGNATURE OF INSPECTOR: [signature]	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	0.9		Surface Condition: moderately weathered with exposed agg. - max. agg. size is 3".			Run: 1 Begin: 0.0 End: 1.2 D.T.: 30 min. Rec: 1.1 Remarks: Pulled off .1' this run.
	1.0		3.0 - 7.15 Concrete: gray, siliceous with some carbonates, max. agg. size is 3", river gravel, subrounded to subangular, good consolidation, entrapped air, entrained air, many voids - none greater than 3/8", @ 3.5: manmade break during retrieval.	100% Run 1	Box 1	
	2.0			100%		Run: 2 Begin: 1.2 End: 3.15 D.T.: 1 hr 20 min Rec: 2.05 Remarks: Picked up .1' from run 1; 100% water retained. Drill action was smooth throughout boring.
	3.0			Run 2		
			E.O.B. @ 3.15'			ABBREVIATIONS: agg: aggregate max: maximum D.T.: drill time Rec: recovery E.O.B.: end of boring.

LOCATION:



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PROJECT Rehab. of Lock & Dam 2, Mon. River | HOLE NO. BR WES M-3

HOLE NO.

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Lock & Dam 2	SHEET 1 OF 1 SHEETS
1. PROJECT: Rehab. of Lock & Dam 2, Mon. River		10. SIZE AND TYPE OF BIT: 3" Diamond Bit	
2. LOCATION (Coordinates or Station): See Remarks		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL	
3. DRILLING AGENCY: USAE-WES		12. MANUFACTURER'S DESIGNATION OF DRILL: KOR-IT, Series A-100, 110 volt	
4. HOLE NO. (As shown on drawing title and file number): BR WES M-4		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0	
5. NAME OF DRILLER: Dan Taylor		14. TOTAL NUMBER CORE BOXES: 1	
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED 90 DEG. FROM VERT. Horizontal		15. ELEVATION GROUND WATER: n/a	
		16. DATE HOLE: STARTED 25 Oct 85; COMPLETED 25 Oct 85	
7. THICKNESS OF OVERBURDEN: 0.0		17. ELEVATION TOP OF HOLE: 725.3'	
8. DEPTH DRILLED INTO ROCK: 3.25		18. TOTAL CORE RECOVERY FOR BORING: 100 %	
9. TOTAL DEPTH OF HOLE: 3.25' in concrete		19. SIGNATURE OF INSPECTOR: [signature]	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	0.0		Surface Condition: moderately weathered with medium scaling from 725.3' to 730.3'. Maximum exposed aggregate size is 1".			Run: 1 Begin: 0.0 End: 3.25 D.T.: 2 hrs 5 min. Rec: 2.95 Remarks: Pulled off .3'. Drill action was smooth. 100% of water was retained.
	1.0					
	2.0		0.0 - 2.95 Concrete: gray, siliceous with some carbonates, maximum aggregate size is ¾", river gravel, subrounded to subangular, good consolidation, entrapped air, entrained air, many voids generally less than ¼" diameter & deep.	100%	Box 1	ABBREVIATIONS: D.T.: drill time Rec: recovery E.O.B.: end of boring
	2.95			Run 1		LOCATION:
			E.O.B. @ 3.25'			Middlewall mono. 20 (-5.7') mono. 19 (-5.2') Small Chamber Flow Riverwall

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PROJECT: Rehab. of Lock & Dam 2, Mon. River | HOLE NO.: BR WES M-4

Hole No. [illegible]

DRILLING LOG	DIVISION Ohio River	INSTALLATION Lock & Dam 2	SHEET 1 OF 1 SHEETS
1. PROJECT Rehab. of Lock & Dam 2, Mon. River		10. SIZE AND TYPE OF BIT [illegible]	
2. LOCATION (Coordinates or Station) See Remarks		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY USAE-WES		12. MANUFACTURER'S DESIGNATION OF DRILL AQ-1, Series A-1, 110 volt	
4. HOLE NO. (As shown on drawing title and file number) BR WES M-5		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 0	UNDISTURBED 0
5. NAME OF DRILLER Dan Taylor		14. TOTAL NUMBER CORE BOXES 1	
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED 90 DEG. FROM VERT. Horizontal		15. ELEVATION GROUND WATER N/A	
7. THICKNESS OF OVERBURDEN 0.3		16. DATE HOLE STARTED 28 Oct 85	COMPLETED 28 Oct 85
8. DEPTH DRILLED INTO ROCK 3.0		17. ELEVATION TOP OF HOLE [illegible]	
9. TOTAL DEPTH OF HOLE 3.3' in Concrete		18. TOTAL CORE RECOVERY FOR BORING 100%	
		19. SIGNATURE OF INSPECTOR Jesse Mc[illegible]	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Descriptions)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	0.3		Surface Condition: slightly weathered with scaling as follows: medium: 724.9 - 732.3 light: 719.6 - 724.3 1.5' downstream from boring: vertical crack with slight separation.	100%	Box 1	Run: 1 Begin: 0.0 End: 3.3 D.T.: 1 hr 15 min. Rec: 3.05 Remarks: Pulled off .25'. Drill action was smooth. 100% of water was retained.
	1.0					
	2.0		0.0 - 3.05 Concrete: gray, siliceous with some carbonates, maximum aggregate size is 3", river gravel, subrounded to subangular, good consolidation, entrapped air, entrained air, many voids generally less than 3/8" diameter & deep.			ABBREVIATIONS: D.T.: drill time Rec: recovery E.O.B.: end of boring
	3.0			Run 1		LOCATION:
			E.O.B. @ 3.3'			LANDWALL Large Chamber ← Flow → 66 ← 22.9 → Mono. 24 MIDDLEWALL

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT)

PROJECT Rehab. of Lock & Dam 2, Mon. River | HOLE NO. BR WES M-5

Hole No. BR WES M-6-86

DRILLING LOG

DIVISION: Ohio River	INSTALLATION: Lock & Dam No. 2 Monongahela River
SHEET 1 OF 10 SHEETS	
1. PROJECT: Rehabilitation Lock & Dam No. 2, Monongahela River	10. SIZE AND TYPE OF BIT: 6" X 7 3/4"
2. LOCATION (Coordinates or Stations): Middle Wall Monolith 25.5' in from land face, 10' U.S. of steps	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: USAE WES	12. MANUFACTURER'S DESIGNATION OF DRILL: Failing Skid Rig
4. HOLE NO. (As shown on drawing title) and file number: BR WES M-6-86	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER: Dan Taylor	14. TOTAL NUMBER CORE BOXES: 33
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: --
7. THICKNESS OF OVERBURDEN: Concrete 65.4'	16. DATE HOLE: STARTED 29 Jan 86 / COMPLETED 11 Feb 86
8. DEPTH DRILLED INTO ROCK: 26.3' shale	17. ELEVATION TOP OF HOLE: 732.5'
9. TOTAL DEPTH OF HOLE: 91.7'	18. TOTAL CORE RECOVERY FOR BORING: Rock 97 %
	19. SIGNATURE OF INSPECTOR: Scott Murrell

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	0.0		Concrete: Looks good, sounds good, entrapped air, maximum size 1/4", entrained air. Aggregate - siliceous with some calcareous, natural and crusned, maximum 2".	100	Box 1	Run: 1 Begin: 0.0' End: 2.3' D.T.: 0 hr, 55 min D. Press: 220 RPM: 100 REC: 2.3' Loss: --
	1.0	MB				
	2.0	MB	Concrete: Looks good, sounds good, entrained air, entrapped air, maximum size 1/4". Aggregate - siliceous with some calcareous, natural and crushed, maximum size 2 1/2".	100	Box 2	Run: 2 Begin: 2.3' End: 4.6 D.T.: 0hr 43 min D. Press: 220 RPM: 100 Rec: 2.3' Loss: --
	3.0					
	4.0	MB	Concrete: Looks good, sounds good, entrained air, entrapped air, maximum size 1/4". Aggregate - siliceous with some calcareous, natural and crushed, maximum size 2 1/2".	100	Box 3	Run: 3 Begin: 4.6' End: 6.2' D.T.: 47 min Loss: -- D. Press: 220 RPM: 100 Rec: 1.8'
	5.0					
	6.0	MB	Concrete: Looks good, sounds good entrained air, entrapped air, maximum size 1/4". Aggregate - siliceous with some calcareous, natural and crushed, maximum size 2 1/2".	100	Box 4	Run: 4 Begin: 6.2' End: 11.25' D.T.: 1hr 15 min D. Press: 200 RPM: 60 Rec: 5.05' Loss: --
	7.0					
	8.0					
	9.0	MB				
	10.0					

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PROJECT: Rehabilitation of Locks & Dam No. 2, Monongahela River

HOLE NO. BR WES M-6-8

Hole No. BR WES M-6-86

DRILLING LOG	DIVISION Ohio River	INSTALLATION Lock & Dam No. 2 Monongahela River	SHEET 2 OF 10 SHEETS
1. PROJECT Rehabilitation Lock & Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT 4" x 7 7/8"	
2. LOCATION (Coordinates or Station) Middle Kill Monolith 25.5' in from land face, 10' U.S. of steps		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY USAE WES		12. MANUFACTURER'S DESIGNATION OF DRILL Failing Skid Rig	
4. HOLE NO. (As shown on drawing title) and file number BR WES M-6-86		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED	UNDISTURBED
5. NAME OF DRILLER Dan Taylor		14. TOTAL NUMBER CORE BOXES 33	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER —	
7. THICKNESS OF OVERBURDEN Concrete 65.4'		16. DATE HOLE: STARTED 29 Jan 86	COMPLETED 11 Feb 86
8. DEPTH DRILLED INTO ROCK 26.3' shale		17. ELEVATION TOP OF HOLE -32.5'	
9. TOTAL DEPTH OF HOLE 91.7'		18. TOTAL CORE RECOVERY FOR BORING Rock 97 %	
		19. SIGNATURE OF INSPECTOR Scorr Murrell	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Descriptions) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	0				Box 5	
	11.0					
			TB			
			Concrete: Looks good, sounds good, entrained air, entrapped air. Maximum size 1/4". Aggregate - siliceous with some calcareous, natural and crushed, maximum size 2 1/2".			Run: 5 Begin: 11.25' End: 16.3' D.T.: 0 hr 35 min D. Press: 200 RPM: 100 Rec: 5.05' Loss: — Comments:
	12.0				Box 6	
	13.0			100		
	14.0					
			TB			
			To get in box.			
	15.0				Box 7	
	16.0					
			TB			
			Concrete: Looks good, sounds good, entrained air, entrapped air. Maximum size 1/4". Aggregate - siliceous and calcareous, natrual and crushed. Maximum size 2 1/2".			Run: 6 Begin: 16.3' End: 21.4' D.T.: 1 hr 0 min D. Press: 200 RPM: 100 Rec: 4.9' Loss: 02.' in hole Comments: Some large limestone aggregate in core sample.
	17.0					
			TB			
			To get in box			
	18.0			100	Box 8	
	19.0					
	20.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT)

PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River | HOLE NO. BR WES M-6-

Hole No. BR WES M-6-86

DRILLING LOG	DIVISION Ohio River	INSTALLATION Lock & Dam No. 2 Monongahela River	SHEET 3 OF 10 SHEETS
1. PROJECT Rehabilitation Lock & Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT 6" X 7 3/4"	
2. LOCATION (Coordinates or Station) Middle Wall Monolith 25.5' in from land face, 10' U.S. of steps		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY USAE WES		12. MANUFACTURER'S DESIGNATION OF DRILL Failing Skid Rig	
4. HOLE NO. (As shown on drawing title) and file number) BR WES M-6-86		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED	UNDISTURBED
5. NAME OF DRILLER Dan Taylor		14. TOTAL NUMBER CORE BOXES 33	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER --	
7. THICKNESS OF OVERBURDEN Concrete 65.4'		16. DATE HOLE STARTED 29 Jan 86	COMPLETED 11 Feb 86
8. DEPTH DRILLED INTO ROCK 26.3' shale		17. ELEVATION TOP OF HOLE 732.5'	
9. TOTAL DEPTH OF HOLE 91.7'		18. TOTAL CORE RECOVERY FOR BORING Rock 97 %	
		19. SIGNATURE OF INSPECTOR Scott Murrell	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Descriptions) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	20.0					
	21.0	MB	Many small air voids honeycombing at 21.0'-21.2'			
	22.0		Concrete: Looks good, sounds good, entrapped air, maximum size 1/2", entrained air. Aggregate - siliceous and some calcareous, natural and crushed, maximum size 3".	100	Box 9	Run: 7 Begin: 21.4' End" 26.2' D.T.: 0 hr 50 min D. Press: 200 RPM: 100 Rec: 5.0' Loss: —
	23.0		Good consolidation.			
	24.0	MB				
	25.0				Box 10	
	26.0	MB	Vuggy at 26.2'			
	27.0		Concrete: Looks good, sounds good, entrained air, lot of entrapped air, maximum size 1/2". Aggregate - siliceous with some calcareous, natural and some crushed, maximum size 3".		Box 11	Run: 8 Begin: 26.2' End: 31.2' D.T.: 0 hr 51 min D. Press: 200 RPM: 100 Rec: 5.0' Loss: —
	28.0					
	29.0	MB				
	30.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River | HOLE NO. BR WES M-6-86

Hole No. BR WES M-6-86

DRILLING LOG | DIVISION: Ohio River | INSTALLATION: Lock & Dam No. 2, Monongahela River | SHEET 4 OF 10 SHEETS

1. PROJECT: Rehabilitation Lock & Dam No. 2, Monongahela River
2. LOCATION (Coordinates or Station): Middle Wall Monolith 25.5' in from land face, 10' U.S. of steps
3. DRILLING AGENCY: USAE WES
4. HOLE NO. (As shown on drawing title and file number): BR WES M-6-86
5. NAME OF DRILLER: Dan Taylor
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: Concrete 65.4'
8. DEPTH DRILLED INTO ROCK: 26.3' shale
9. TOTAL DEPTH OF HOLE: 91.7'
10. SIZE AND TYPE OF BIT: 6" X 7 3/4"
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
12. MANUFACTURER'S DESIGNATION OF DRILL: Failing Skid Rig
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED _____ UNDISTURBED _____
14. TOTAL NUMBER CORE BOXES: 33
15. ELEVATION GROUND WATER: --
16. DATE HOLE: STARTED 29 Jan 86 COMPLETED 11 Feb 86
17. ELEVATION TOP OF HOLE: 732.5'
18. TOTAL CORE RECOVERY FOR BORING: Rock 97 %
19. SIGNATURE OF INSPECTOR: Scott Murrell

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	30.0				Box 12	
	31.0	MB				
	32.0		Concrete: Looks good, sounds good, entrained air, entrapped air, maximum size 1/2". Aggregate - siliceous with some calcareous, natural and crushed, maximum size 3".	100	Box 13	Run: 9 Begin: 31.2' End: 36.3" D.T.: 1 hr 00 min D. Press: 200 RPM: 100 Rec: 5.1' Loss: --
	33.0					
	34.0	MB	To get in box			
	35.0				Box 14	
	36.0	MB				
		MB				
	37.0		Concrete: Looks good, sounds good, entrained air, entrapped air, maximum size 1/2". Aggregate - siliceous with some calcareous, natrual and crushed, maximum size 3 1/2".			Run: 10 Begin: 36.3' End: 41.5' D.T.: 1 hr 05 min D. Press: 200 RPM: 100 Rec: 4.9' Loss: 0.3 in hole
	38.0	MB		100	15	Comments: Construction joint at 40.8', pieces separated when removed from core barrel.
	39.0					
	40.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: Rehabilitation of Lock & Dam No. 2, Monongahela River | HOLE NO. BR WES M-6-8

Hole No. BR WES M-6-86

DRILLING LOG	DIVISION Ohio River	INSTALLATION Lock & Dam No. 2 Monongahela River	SHEET 5 OF 10 SHEETS
1. PROJECT Rehabilitation Lock & Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT 5" X 7 3/4"	
2. LOCATION (Coordinates or Station) Middle Wall Monolith 25.5' in from land face, 10' U.S. of steps		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY USAE WES		12. MANUFACTURER'S DESIGNATION OF DRILL Failing Skid Rig	
4. HOLE NO. (As shown on drawing title) and file number BR WES M-6-86		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED	UNDISTURBED
5. NAME OF DRILLER Dan Taylor		14. TOTAL NUMBER CORE BOXES 33	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER --	
7. THICKNESS OF OVERBURDEN Concrete 65.4'		16. DATE HOLE STARTED 29 Jan 86	COMPLETED 11 Feb 86
8. DEPTH DRILLED INTO ROCK 26.3' shale		17. ELEVATION TOP OF HOLE 732.5'	
9. TOTAL DEPTH OF HOLE 91.7'		18. TOTAL CORE RECOVERY FOR BORING Rock 97 %	
		19. SIGNATURE OF INSPECTOR Scott Murrell	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	40.8'					
	41.0		Construction joint.			
		MB				Run: 11 Begin: 41.5' End: 46.4' D.T.: 1 hr 47 min D. Press: 200 RPM: 100 Rec: 5.1' Loss: ----
	42.0		Concrete: Looks good, sounds good, entrained air, entrapped air, maximum size 1/2". Aggregate - siliceous and calcareous, natural and crushed, maximum size 3".		Box 16	Comments: Encountered construction joint at 45.0' on side of core.
	43.0			100		
	44.0					
		MB	To get in box.			
	45.0				Box 17	
		MB	Construction joint on side.			
	46.0					
		MB	Concrete: Looks good, sounds good, entrained air, entrapped air, maximum size 1/2". Aggregate - siliceous and calcareous, natural and crushed, maximum size 2-1/2".			Run: 12 Begin: 46.4' End: 51.45' D.T.: 2 hr 30 min D. Press: 200 RPM: 100 Rec: 5.1' Loss: ----
	47.0					
		MB				Comments: Joint still present.
	48.0			100	Box 18	
	49.0					
	50.0					

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PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River

HOLE NO. BR WES M-6-86

Hole No. BR WES M-6-86

DRILLING LOG	DIVISION Ohio River	INSTALLATION Lock & Dam No. 2 Monongahela River	SHEET 6 OF 10 SHEETS
1. PROJECT Rehabilitation Lock & Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT 6" X 7 3/4"	
2. LOCATION (Coordinates or Station) Middle Wall Monolith 25.5' in from land face, 10' U.S. of steps		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY USAE WES		12. MANUFACTURER'S DESIGNATION OF DRILL Failing Skid Rig	
4. HOLE NO. (As shown on drawing title) and file number BR WES M-6-86		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED	UNDISTURBED
5. NAME OF DRILLER Dan Taylor		14. TOTAL NUMBER CORE BOXES 33	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER --	
7. THICKNESS OF OVERBURDEN Concrete 65.4		16. DATE HOLE STARTED 29 Jan 86	COMPLETED 11 Feb 86
8. DEPTH DRILLED INTO ROCK 26.3' shale		17. ELEVATION TOP OF HOLE 732.5'	
9. TOTAL DEPTH OF HOLE 91.7'		18. TOTAL CORE RECOVERY FOR BORING Rock 97 %	
		19. SIGNATURE OF INSPECTOR Scott Murrell	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	50.0				Box 18	
	51.0	MB				
		MB	Concrete: Looks good, sounds good, entrained air, entrapped air, maximum size 1/2".			Run: 13 Began: 51.4' End: 56.5' D.T.: 1 hr 10 min D. Press: 200 RPM: 100 Rec: 5.1' Loss: --- Comments: Joint still present.
	52.0				Box 19	
	53.0	MB		100		
	54.0	MB	To get in box. 1/8" rebar in strip at 54.2'.			
	55.0		Joint on strip at 54.95'.		Box 20	
	56.0					
		MB				
	57.0	MB	Concrete: Looks good, sounds good, entrapped air, entrained air, maximum size 1/2". Aggregate - siliceous and calcareous, natural and crushed, maximum size 2-1/2".		Box 21	Run: 14 Begin: 56.5' End: 61.6' D.T.: 1 hr 33 min D. Press: 200 RPM: 100 Rec: 4.6' Loss: 0.5 in hole Comments: Joint still present.
	58.0	MB		100		
	59.0	MB				
	60.0					

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PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River | HOLE NO. BR WES M-6-8

Hole No. [illegible] M-6-86

DRILLING LOG

DIVISION: Ohio River

INSTALLATION: Monongahela River

SHEET 7 of 10 SHEETS

1. PROJECT: Rehabilitation Lock & Dam No. 2, Monongahela River
2. LOCATION (Coordinates or Station): Middle Wall Monolith 25.5' in from land face, 10' U.S. of steps
3. DRILLING AGENCY: USAE WES
4. HOLE NO. (As shown on drawing title) and file number: BR WES M-6-86
5. NAME OF DRILLER: Dan Taylor
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: Concrete 65.4'
8. DEPTH DRILLED INTO ROCK: 26.3' shale
9. TOTAL DEPTH OF HOLE: 91.7'
10. SIZE AND TYPE OF BIT: A" X 3 3/4"
11. DATUM FOR ELEVATION SHOWN (MSL or USC&GS): MSL
12. MANUFACTURER'S DESIGNATION OF DRILL: Failing Skid Rig
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED: ; UNDISTURBED:
14. TOTAL NUMBER CORE BOXES: 33
15. ELEVATION GROUND WATER: --
16. DATE HOLE: STARTED 29 Jan 86; COMPLETED 11 Feb 86
17. ELEVATION TOP OF HOLE: 732.5'
18. TOTAL CORE RECOVERY FOR BORING: Rock 97 %
19. SIGNATURE OF INSPECTOR: Scott Murrell

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
	60.0		Joint fades out in this area			
	61.0	MB				Run: 15 Begin: 61.6' End: 66.0' D.T.: 3 hr 10 min D. Press: 200 RPM: 100 Rec: 4.6' Loss: 0.3' in hole Comments: Water turned a gray-blue milky color indicating shale was reached. 0.3' of gray shale was pulled up with concrete. Closed contact.
			Concrete: Looks good, sounds good, entrained air, entrapped air, maximum size 1/2".		Box 22	
	62.0					
		MB	Aggregate - siliceous and calcareous, natural and crushed, maximum size 2-1/2".			
	63.0	MB		98		
	64.0				Box 23	
	65.0					
	66.0					Run: 16 Begin: 66.0' End: 71.0' D.T.: 2 hr 10 min D. Press: 200 RPM: 100 Rec.: 4.5' Loss: 0.6' in hole 0.2' ground up Comments: Top 0.2' fragmented and washed away when drilling started.
		MB's	65.4'-67.7'			
	67.0		Shale, gray, moderately hard, slightly silty.	96	Box 24	
			Healed fracture.			
	68.0	MB	Healed fracture.			
		MB				
	69.0	MB				
	70.0	MB				

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PROJECT: Rehabilitation of Lock & Dam No. 2, Monongahela River

HOLE NO.: BR WES M-6-8

Hole No. BR WES M-6-86

DRILLING LOG | DIVISION Ohio River | INSTALLATION Lock & Dam No. 2 Monongahela River | SHEET 8 OF 10 SHEETS

1. PROJECT Rehabilitation Lock & Dam No. 2, Monongahela River
2. LOCATION (Coordinates or Stations) Middle Wall Monolith 25.5' in from land face, 10' U.S. of steps
3. DRILLING AGENCY USAE WES
4. HOLE NO. (As shown on drawing title and file number) BR WES M-6-86
5. NAME OF DRILLER Dan Taylor
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN Concrete 65.4'
8. DEPTH DRILLED INTO ROCK 26.3' shale
9. TOTAL DEPTH OF HOLE 91.7'
10. SIZE AND TYPE OF BIT [illegible]
11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
12. MANUFACTURER'S DESIGNATION OF DRILL Failing Skid Rig
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED _____ UNDISTURBED _____
14. TOTAL NUMBER CORE BOXES 33
15. ELEVATION GROUND WATER --
16. DATE HOLE: STARTED 29 Jan 86 COMPLETED 11 Feb 86
17. ELEVATION TOP OF HOLE 732.5'
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR Scott Murrell

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Descriptions) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	70.0	MB			25	
		MB	Natural break.			
		MB	Natural break.			Run: 17 Begin: 70.4' End: 74.4' D.T.: 2 hr 20 min Rec: 3.4' Loss: 0.5', in hole 0.1' fragmented and lost from top of core sample by drilling action.
	71.0	MB				
		MB	Shale, gray, moderately hard, slightly silty.	98		
	72.0		Brown sandy siliceous inclusion.			
		MB			26	
	73.0		Healed Fracture.			
		MB				
		MB				
		MB				
	74.0				27	
						Run: 18 Begin: 74.4' End: 79.2' D.T.: 1 hr 47 min Rec: 4.8' Loss: 0.2' in hole
	75.0		Shale gray, moderately hard, slightly silty.			
		MB				
		MB				
	76.0		Healed vertical fractures.	99		
	77.0	MB				
					28	
		MB				
	78.0					
		MB				
	79.0	MB				
	80.0					

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE | PROJECT Rehabilitation of | HOLE NO.

B-1

Hole No. BR WES M-6-86

DRILLING LOG	DIVISION Ohio River	INSTALLATION Lock & Dam No. 2, Monongahela River	SHEET 9 OF 10 SHEETS
1. PROJECT Rehabilitation Lock & Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT A X 3 3/4"	
2. LOCATION (Coordinates or Station) Middle wall Monolith 25.5' in from land face, 10' U.S. of steps		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY USAE WES		12. MANUFACTURER'S DESIGNATION OF DRILL Failing Skid Rig	
4. HOLE NO. (As shown on drawing title and file number) BR WES M-6-86		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN (DISTURBED / UNDISTURBED)	
5. NAME OF DRILLER Dan Taylor		14. TOTAL NUMBER CORE BOXES 33	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER --	
7. THICKNESS OF OVERBURDEN Concrete 65.4'		16. DATE HOLE STARTED 29 Jan 86 / COMPLETED 11 Feb 86	
8. DEPTH DRILLED INTO ROCK 26.3' shale		17. ELEVATION TOP OF HOLE 732.5'	
9. TOTAL DEPTH OF HOLE 91.7'		18. TOTAL CORE RECOVERY FOR BORING Rock 97 %	
		19. SIGNATURE OF INSPECTOR Scott Murrell	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
					29	
	81.0		Shale, gray, moderately hard, slightly silty.			Run: 19 Begin: 79.2' End: 84.5' Rec: 5.0' D.T.: 2 hr Loss: 0.3' left in hole.
	82.0		Open vertical fractures.	98		
	83.0				30	
	84.0					
	85.0		Shale gray, moderately hard, slightly silty.			Run: 20 Begin: 84.5' End: 87.0' Rec.: 2.6' D.T.: 50 min Loss: 0.2' left in hole
			Healed vertical fracture.	90	31	
	86.0					
	87.0					Run: 21 Begin: 87.0' End: 91.7' Rec: 4.7' D.T.: 2 hr 40 min
	88.0		Shale gray, moderately hard, slightly silty.			
					32	
	89.0		Healed fractures.	100		
	90.0					

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PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River | HOLE NO. BR WES M-6-8

Hole No. BR WES M-6-86

DRILLING LOG	DIVISION Ohio River	INSTALLATION Lock & Dam No. 2 Monongahela River	SHEET 10 OF 10 SHEETS
1. PROJECT Rehabilitation Lock & Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT O A / 3/4"	
2. LOCATION (Coordinates or Station) Middle Wall Monolith 25.5' in from land face, 10' U.S. of steps		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY USAE WES		12. MANUFACTURER'S DESIGNATION OF DRILL Failing Skid Rig	
4. HOLE NO. (As shown on drawing title) and file number BR WES M-6-86		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED	UNDISTURBED
5. NAME OF DRILLER Dan Taylor		14. TOTAL NUMBER CORE BOXES 33	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER —	
7. THICKNESS OF OVERBURDEN Concrete 65.4'		16. DATE HOLE STARTED 29 Jan 86	COMPLETED 11 Feb 86
8. DEPTH DRILLED INTO ROCK 26.3' shale		17. ELEVATION TOP OF HOLE 732.5'	
9. TOTAL DEPTH OF HOLE 91.7'		18. TOTAL CORE RECOVERY FOR BORING Rock 97 %	
		19. SIGNATURE OF INSPECTOR Scott Murrell	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Descriptions) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	91.0		Shale, gray, moderately hard, slightly silty.		33	
			E.O.B. @ 91.7'.			
	92.0					Abbreviations D.T. - Drill time D. Press - Drill pressure Rec. - Recovery E.O.B. - End of Boring M.B. - Mechanical break N.B. - Natural break U.S. - Upstream Mod. - Moderately

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PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River

HOLE NO. BR WES M-6-6

Hole No. BR WES R-1-86

DRILLING LOG	DIVISION Ohio River	INSTALLATION Lock & Dam No. 2, Monongahela River	SHEET 1 OF 1 SHEETS
1. PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT 6" - thin wall	
2. LOCATION (Coordinates or Station) Upper guard wall, monolith R-5, in line w/M-R & M-2 joint, 3.0' in from land face		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY USAE WES		12. MANUFACTURER'S DESIGNATION OF DRILL Kor-It, Series K-100, 110 volts	
4. HOLE NO. (As shown on drawing title) and file number BR WES R-1-86		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED	UNDISTURBED
5. NAME OF DRILLER Dan Taylor		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN ----		16. DATE HOLE STARTED 12 Feb 86	COMPLETED 13 Feb 86
8. DEPTH DRILLED INTO ROCK concrete 1.7'		17. ELEVATION TOP OF HOLE 730.5'	
9. TOTAL DEPTH OF HOLE 1.7'		18. TOTAL CORE RECOVERY FOR BORING 100 %	
		19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Top surface intact, broken on removal from hole.			
	1.0		Concrete good, natural and crusned siliceous aggregate maximum 1-1/2".	100	Box 1	
	2.0		Has entrapped and entrained air.			

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PROJECT Rehabilitation of Locks & Dam No. 2, Monongahela River — HOLE NO. BR WES R-1-8

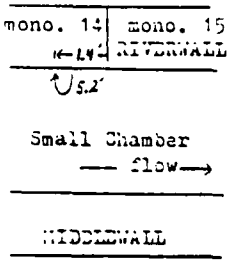
Hole No. -

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Lock & Dam #2	SHEET 1 OF 1 SHEETS

1. PROJECT: Rehab. of Lock & Dam 2, Mon. River	10. SIZE AND TYPE OF BIT: [illegible] Diamond Bit
2. LOCATION (Coordinates or Station): See Remarks	11. DATUM FOR ELEVATION SHOWN (USM or MSL): USL
3. DRILLING AGENCY: USAE-WES	12. MANUFACTURER'S DESIGNATION OF DRILL: CCR-II, Series A-165, 110 volt
4. HOLE NO. (As shown on drawing title and file number): BR WES R-3	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 0 / UNDISTURBED 0
5. NAME OF DRILLER: Dan Taylor	14. TOTAL NUMBER CORE BOXES: 1
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED 90 DEG. FROM VERT. Horizontal	15. ELEVATION GROUND WATER: n/a
7. THICKNESS OF OVERBURDEN: 0.0	16. DATE HOLE: STARTED 25 Oct 85 / COMPLETED 25 Oct 85
8. DEPTH DRILLED INTO ROCK: 3.0	17. ELEVATION TOP OF HOLE: 725.71
9. TOTAL DEPTH OF HOLE: 3.1' in Concrete	18. TOTAL CORE RECOVERY FOR BORING: 100%
	19. SIGNATURE OF INSPECTOR: [signature]

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	0.0		Surface Condition: Moderately weathered with medium scaling - max. agg. size is 2". Severe scaling is at joints.	100% Run 1		Run: 1 Begin: 0.0 End: 1.15 D.T: 1 hr. Rec: 1.1 Remarks: Pulled off .05'.
	1.0		0.0 - 3.1 Concrete: gray, siliceous with some carbonates, max. agg. size is 3", river gravel, subrounded to subangular, good consolidation, entrapped air, entrained air, many voids - none greater than ¼" diameter & deep unless noted, @ .75: ¼" steel. @ .85: 1" steel. @ 2.1: void - 3/8" diameter, ½" deep, 3/4" long.	100%	Box 1	Run: 2 Begin: 1.15 End: 3.1 D.T: 1 hr 45 min. Rec: 2.0 Remarks: Picked up .05' from run 1. Drill action was smooth throughout boring. 100% of water was retained.
	2.0					
	3.0		E.O.B. @ 3.1'	Run 2		ABBREVIATIONS: agg: aggregate max: maximum D.T.: drill time Rec: recovery E.O.B.: end of boring.

LOCATION:



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PROJECT: Rehab. of Lock & Dam 2, Mon. River | HOLE NO.: BR WES R-3

Hole No. ...-...

DRILLING LOG

DIVISION: Ohio River	INSTALLATION: Lock & Dam #2
	SHEET 1 OF 1 SHEETS
1. PROJECT: Rehab. of Lock & Dam 2, Mon. River	10. SIZE AND TYPE OF BIT: ...Diamond Bit
2. LOCATION (Coordinates or Station): See Remarks —	11. DATUM FOR ELEVATION SHOWN (MSL or USL): USL
3. DRILLING AGENCY: USAE-WES	12. MANUFACTURER'S DESIGNATION OF DRILL: ...KOR-12, Series K-100, 110
4. HOLE NO. (As shown on drawing title) and file number: BR WES R-4	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0
5. NAME OF DRILLER: Dan Taylor	14. TOTAL NUMBER CORE BOXES: 1
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED Horizontal 90 DEG. FROM VERT.	15. ELEVATION GROUND WATER: n/a
	16. DATE HOLE: STARTED 24 Oct 85; COMPLETED 24 Oct 85
7. THICKNESS OF OVERBURDEN: 0.0	17. ELEVATION TOP OF HOLE: 715.0
8. DEPTH DRILLED INTO ROCK: 0.0	18. TOTAL CORE RECOVERY FOR BORING: 100 %
9. TOTAL DEPTH OF HOLE: 3.1' in Concrete	19. SIGNATURE OF INSPECTOR: [signature]

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	0.0		Surface Condition: badly weathered with severe scaling - max. agg. size is 3".	100%		Run: 1 Begin: 0.0 End: 1.15 D.T.: 40 min. Rec: 1.15 Remarks: -
	1.0		0.0 - 3.1 Concrete: gray, siliceous with some carbonates, max. agg. size is 3", river gravel, subrounded to subangular, good consolidation, entrapped air, entrained air, many voids - none greater than ¾" diameter & deep unless noted,	Run 1	Box 1	
	2.0		@ .1: 3/4" long & ½" deep void. @ .2: incipient cracks - through some agg. @ .35: manmade break during retrieval. @ .5: manmade break during retrieval.	100%		Run: 2 Begin: 1.15 End: 3.1 D.T.: 1 hr 45 min. Rec: 1.95 Remarks: 100% of water was retained. Drill action was smooth throughout boring.
	3.0		E.O.B. @ 3.1'	Run 2		ABBREVIATIONS: agg: aggregate max: maximum D.T: drill time Rec: recovery E.O.B: end of boring.

LOCATION:

Riverwall

mono. 17 — mono. 18

(-17'-4) 15.5'

Small Chamber — flow →

MIDDLEWALL

ENG FORM 1836 MAR 71 — PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: Rehab. of Lock & Dam 2, Mon. River — HOLE NO.: BR WES R-4

Hole No. BR WES R-5-86

DRILLING LOG	DIVISION Ohio River	INSTALLATION Lock & Dam No. 2, Monongahela Rive.	SHEET 1 OF 10 SHEETS
1. PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT 6" X 7 7/4"	
2. LOCATION (Coordinates or Station) River Wall Monolith R-23, 6.7' U.S. of R-24 Joint and 5.8'		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY landward from river face USAE-WES		12. MANUFACTURER'S DESIGNATION OF DRILL Failing Skid Rig	
4. HOLE NO. (As shown on drawing title) and file number BR WES R-5-86		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED	UNDISTURBED
5. NAME OF DRILLER Dan Taylor		14. TOTAL NUMBER CORE BOXES 32	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN 67.5' concrete		16. DATE HOLE STARTED 18 Dec 85	COMPLETED 24 Jan 86
8. DEPTH DRILLED INTO ROCK 23.2' shale		17. ELEVATION TOP OF HOLE 730.5'	
9. TOTAL DEPTH OF HOLE 90.7'		18. TOTAL CORE RECOVERY FOR BORING Rock 99 %	
		19. SIGNATURE OF INSPECTOR Scott Murrell	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	1.0		Concrete: Looks good. Entrained air, entrapped air, maximum size 1/2".		1	
	2.0		Aggregate - natural and crushed, siliceous and calcareous, maximum size 2".			
	3.0					
	4.0					
	5.0				2	
	6.0					
	7.0		Concrete: Looks good. Entrained air, entrapped air. Maximum size 1/4".			
	8.0		Aggregate - natural and crushed siliceous and calreous, maximum size 2 1/4".		3	
	9.0					

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PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River

HOLE NO. BR WES R-5-86

Hole No. BR WES R-5-86

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Lock & Dam No. 2, Monongahela River	SHEET 2 OF 10 SHEETS
1. PROJECT: Rehabilitation of Lock & Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT: 6" X [illegible]"	
2. LOCATION (Coordinates or Station): River Wall Monolith R-23, 6.7' U.S. of R-24 Joint and 5.8' landward from river face		11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL	
3. DRILLING AGENCY: USAE-WES		12. MANUFACTURER'S DESIGNATION OF DRILL: Failing Skid Rig	
4. HOLE NO. (As shown on drawing title and file number): BR WES R-5-86		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED	UNDISTURBED
5. NAME OF DRILLER: Dan Taylor		14. TOTAL NUMBER CORE BOXES: 32	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
		16. DATE HOLE: STARTED 18 Dec 85	COMPLETED 24 Jan 86
7. THICKNESS OF OVERBURDEN: 67.5' concrete		17. ELEVATION TOP OF HOLE: 730.5'	
8. DEPTH DRILLED INTO ROCK: 23.2' shale		18. TOTAL CORE RECOVERY FOR BORING: Rock 99 %	
9. TOTAL DEPTH OF HOLE: 90.7'		19. SIGNATURE OF INSPECTOR: Scott Murrell	

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
	10.0					
			Concrete: Looks good, sounds good. entrained air, entrapped air, maximum size 1/4".			
	11.0				4	
			Aggregate - natural and crusned. maximum size 2-1/4", siliceous and caicareous.			
	12.0					
	13.0					
	14.0				5	
	15.0					
	16.0		MB Concrete: Looks good, sounds good. Entrained air, entrapped air, maximum size 1/4".			Run: 1 Begin: 16.1' End: 21.3' D.T.: 1 hr 21 min D. Press: 220 RPM: ≈100 Rec: 5.0' Loss: 0.2' in hole
	17.0		Aggregate natural and crushed, maximum size 2-1/2", siliceous.	100	6	
	18.0					
	19.0					
	20.0					

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PROJECT: Rehabilitation of Lock & Dam No. 2, Monongahela River

HOLE NO.: BR WES R-5-86

Hole No. BR WES R-5-86

DRILLING LOG	DIVISION Ohio River	INSTALLATION Lock & Dam No. 2, Monongahela River	SHEET 3 OF 10 SHEETS
1. PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT 6" X 7 3/4"	
2. LOCATION (Coordinates or Station) River Wall Monolith R-23, 6.7' U.S. of R-24 Joint and 5.8' landward from river face		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY USAE-WES		12. MANUFACTURER'S DESIGNATION OF DRILL Failing Skid Ri-	
4. HOLE NO. (As shown on drawing title) and file number) BR WES R-5-86		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED	UNDISTURBED
5. NAME OF DRILLER Dan Taylor		14. TOTAL NUMBER CORE BOXES 32	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
		16. DATE HOLE: STARTED 18 Dec 85	COMPLETED 24 Jan 86
7. THICKNESS OF OVERBURDEN 67.5' concrete		17. ELEVATION TOP OF HOLE 730.5'	
8. DEPTH DRILLED INTO ROCK 23.2' shale		18. TOTAL CORE RECOVERY FOR BORING Rock 99 %	
9. TOTAL DEPTH OF HOLE 90.7'		19. SIGNATURE OF INSPECTOR Scott Murrell	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	20.0			100		
	21.0	MB			7	
	22.0					Run: 2 Begin: 21.3' End: 26.2' D.T.: 2 hr 00 min Rec: 5.0' Loss: 0.2' in hole D. Press: 220 RPM: ≃100
	23.0	MB	Rebar, 3/4" at 22.8'.	100		
			Concrete: Looks good, sounds good. Entrained air, entrapped air, maximum size 1/2".			
	24.0		Aggregate - siliceous, natural and crushed, maximum size 1-1/2".		8	
	25.0					
		MB	2" Conduit pipe.			
	26.0	MB				
			Concrete: Looks good, sounds good. Entrained air, entrapped air, maximum size 1/2".	100		Run: 3 Begin: 26.2' End: 31.0' D.T.: 2 hr 00 min D. Press: 220 RPM: ≃100 Rec: 5.0' Loss: ---
	27.0		Aggregate - siliceous, natural and crushed, maximum size 2-1/4".		9	
	28.0	MB	Rebar, 1" diameter, at 27.0', 27.2', and 27.5'-28.0'.			
	29.0					
	30.0				10	

Hole No. BR WES R-5-86

DRILLING LOG	DIVISION Ohio River	INSTALLATION Lock & Dam No. 2, Mononganela River	SHEET 4 OF 10 SHEETS
1. PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT 6" X 7 3/4"	
2. LOCATION (Coordinates or Station) River Wall Monolith R-23, 6.7' U.S. of R-24 Joint and 5.8' landward from river face		11. DATUM FOR ELEVATION SHOWN (USM or MSL) MSL	
3. DRILLING AGENCY USAE-WES		12. MANUFACTURER'S DESIGNATION OF DRILL Failing Skid Rig	
4. HOLE NO. (As shown on drawing title) and file number BR WES R-5-86		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED	UNDISTURBED
5. NAME OF DRILLER Dan Taylor		14. TOTAL NUMBER CORE BOXES 32	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN 67.5' concrete		16. DATE HOLE STARTED 18 Dec 85 COMPLETED 24 Jan 86	
8. DEPTH DRILLED INTO ROCK 23.2' shale		17. ELEVATION TOP OF HOLE 730.5'	
9. TOTAL DEPTH OF HOLE 90.7'		18. TOTAL CORE RECOVERY FOR BORING Rock 99 %	
		19. SIGNATURE OF INSPECTOR Scott Murrell	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	30.0				10	
	31.0		MB			
			Concrete: Looks good, sounds good. Entrained air, entrapped air, maximum size 1/2".			
	32.0		Aggregate - siliceous, natural and crushed, maximum size 2".		11	Run: 4 Begin: 31.0' End: 36.2' D.T.: 2 hr 42 min D. Press: 220 RPM: ≃100 Rec: 5.1' Loss: 0.1' in hole
				100		
	33.0		MB			
	34.0				12	
	35.0		MB			
	36.0		MB			
			Concrete: Looks good, sounds good. Entrained air, entrapped air maximum size 1/4".			
	37.0		Aggregate - siliceous, natural and crushed, maximum size 2".		13	Run: 5 Begin: 36.2' End: 41.2' D.T.: 0 hr 57 min D. Press: 240 RPM: ≃100 Rec: 5.1' Loss: —
	38.0			100		
	39.0					
	40.0					

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PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River

HOLE NO. BR WES R-5-8

Hole No. BR WES R-5-86

DRILLING LOG	DIVISION Ohio River	INSTALLATION Lock & Dam No. 2, Monongahela River	SHEET 5 OF 10 SHEETS

1. PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River
2. LOCATION (Coordinates or Station) River Wall Monolith R-23, 6.7' U.S. of R-24 Joint and 5.8' landward from river face
3. DRILLING AGENCY USAE-WES
4. HOLE NO. (As shown on drawing title) and file number BR WES R-5-86
5. NAME OF DRILLER Dan Taylor
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN 67.5' concrete
8. DEPTH DRILLED INTO ROCK 23.2' shale
9. TOTAL DEPTH OF HOLE 90.7'
10. SIZE AND TYPE OF BIT 5" X 7 3/4"
11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
12. MANUFACTURER'S DESIGNATION OF DRILL Failing Skid Rig
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
14. TOTAL NUMBER CORE BOXES 32
15. ELEVATION GROUND WATER
16. DATE HOLE — STARTED 9 Dec 85 — COMPLETED 24 Jan 86
17. ELEVATION TOP OF HOLE 730.5'
18. TOTAL CORE RECOVERY FOR BORING Rock 99 %
19. SIGNATURE OF INSPECTOR Scott Murrell

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	40.0				14	
	41.0	MB	Concrete: Looks good, sounds good. Entrained air, entrapped air, maximum size 5/8". Aggregate - siliceous, natural and crushed, maximum size 2-1/4".			
	42.0	MB			15	Run: 6 Begin: 41.2' End: 46.2' D.T.: 2 hr 42 min RPM: ≈100 D. Press: 240 Rec: 5.0' Loss: 0.1' Comments: Barrel came up without core. Fished for it without success. Tried again 21 Jan and recovered core.
	43.0	MB		100		
	44.0				16	
	45.0					
	46.0					
		MB	Concrete: Looks good, sounds good. Entrained air, entrapped air, maximum size 1/4".	100	17	Run: 7 Begin: 46.2' End: 47.5' D.T.: 1 hr 08 min D. Press: 240 RPM: ≈100 Rec: 1.3' Loss: — Comments: Striations on core caused by retrieval.
	47.0					
	48.0	MB				
	49.0					
		MB		100		
	50.0					

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PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River — HOLE NO. BR WES R-5-86

Hole No. BR WES R-5-86

DRILLING LOG

Division: Ohio River	Installation: Lock & Dam No. 2, Monongahela River
Sheet: 1 of 10 sheets	
1. Project: Rehabilitation of Lock & Dam No. 2, Monongahela River	10. Size and type of bit: 6" X 7 1/4"
2. Location (Coordinates or Station): River Wall Monolith R-23, 6.7' U.S. or R-24 Joint and 5.8' landward from river face	11. Datum for elevation shown (USM or MSL): MSL
3. Drilling agency: USAE-WES	12. Manufacturer's designation of drill: Failing Skid Rig
4. Hole No. (As shown on drawing title): BR WES R-5-86	13. Total no. of overburden samples taken: Disturbed / Undisturbed
5. Name of driller: Dan Taylor	14. Total number core boxes: 32
6. Direction of hole: ☒ Vertical ☐ Inclined ____ deg. from vert.	15. Elevation ground water:
7. Thickness of overburden: 47.5' concrete	16. Date hole: Started 19 Dec 85 / Completed 24 Jan 86
8. Depth drilled into rock: 33.2' shale	17. Elevation top of hole: 730.5'
9. Total depth of hole: 90.7'	18. Total core recovery for boring: Rock 99 %
	19. Signature of inspector: Scott Murrell

Elevation	Depth	Legend	Classification of Materials (Description)	% Core Recovery	Box or Sample No.	Remarks (Drilling time, water loss, depth of weathering, etc., if significant)
	50.0		Concrete: Looks good, sounds good. Entrained air, entrapped air, maximum size 1/2". Aggregate - siliceous, natural and crushed, maximum size 2-1/2".	100	18	Run: 8 Begin: 47.5' End: 52.3' D.T.: 1 hr 11 min D. Press: 240 RPM: ≃100 Rec: 4.8' Loss: —
	51.0		MB			
	52.0		MB			
	53.0		Concrete: Looks good, sounds good. Entrained air, entrapped air, maximum size 1/2". Aggregate - siliceous and calcareous, natural and crushed, maximum size 2-1/4"	90	19	Run: 9 Begin: 52.3' End: 57.1' D.T.: 2 hr 21 min D. Press: 240 RPM: ≃100 Rec: 4.5' Loss: 0.4 ground up Comments: Break at 55' had missing section approximately 0.4' due to section being broken up. This section was removed from core barrel as aggregate and loose pieces of concrete. This is best estimate of length of section. Measuring tape lowered to bottom of hole read 57.1'.
	54.0		MB			
	55.0		MB			
			MB		20	
	56.0					
	57.0		MB			Run: 10 Begin: 57.1' End: 62.3' D.T.: 1 hr 45 min D. Press: 240 RPM: ≃100 Rec: 5.2' Loss: 0.1' in hole
	58.0		Concrete: Looks good, sounds good. Entrained air, entrapped air, maximum size 1/4". Aggregate - siliceous and calcareous, natural and crushed, maximum size 2-1/4"		21	
	59.0					
	60.0					

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Project: Rehabilitation of Lock & Dam No. 2, Monongahela River — Hole No.: BR WES R-5-

Hole No. BR WES R-5-86

DRILLING LOG

DIVISION: Ohio River	INSTALLATION: Monongahela River
SHEET 7 OF 10 SHEETS	
1. PROJECT: Rehabilitation of Lock & Dam No. 2, Monongahela River	10. SIZE AND TYPE OF BIT: 6" X 7 3/4"
2. LOCATION (Coordinates or Station): River Wall Monolith R-23, 6.7' U.S. of R-24 Joint and 5.8' landward from river face	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: USAE-WES	12. MANUFACTURER'S DESIGNATION OF DRILL: Failing Skid Rig
4. HOLE NO. (As shown on drawing title) and file number: BR WES R-5-86	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER: Dan Taylor	14. TOTAL NUMBER CORE BOXES: 32
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER:
7. THICKNESS OF OVERBURDEN: 67.5' concrete	16. DATE HOLE: STARTED 8 Dec 85 / COMPLETED 24 Jan 86
8. DEPTH DRILLED INTO ROCK: 23.2' shale	17. ELEVATION TOP OF HOLE: 730.5'
9. TOTAL DEPTH OF HOLE: 90.7'	18. TOTAL CORE RECOVERY FOR BORING: Rock 99 %
	19. SIGNATURE OF INSPECTOR: Scott Murrell

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	60.0		MB - 2 pieces 1" rebar at 60.4'.			
	61.0			100	22	
	62.0		MB			Run: 11 Begin: 62.3' End: 66.5' D.T.: 3 hr 00 min D. Press: 240 RPM: ≃100 Rec: 4.2' Loss: 0.1' in hole Comments:
			Concrete: Looks good, sounds good. entrained air, entrapped air, maximum size 1/2".			
	63.0		MB Aggregate - siliceous and calcareous, natural and crushed, max mum size 2-3/4".			
	64.0			100	23	
	65.0					
	66.0					
	67.0					Run: 12 Begin: 66.5' End: 71.6' D.T.: 2 hr 55 min D. Press: 240 RPM: ≃100 Rec: 5.1' Loss: --- Comments: Reached concrete - rock open interface. Rock is gray shale, sandy. Layer of gravel between concrete and rock. Layer of burlap on bottom of concrete. Gravel is siliceous with a waxy coating.
			MB Concrete rock interface.			
			MB			
	68.0		MB	98		
			MB			
			Gray shale, moderately			
			MB hard, slightly sandy, with calcareous inclusions.		24	
	69.0					
			MB			
	70.0					

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PROJECT: Rehabilitation of Locks & Dam No. 2, Monongahela River

HOLE NO.: BR WES R-5-

Hole No. BR WES R-5-86

DRILLING LOG

Division: Ohio River

Installation: Lock & Dam No. 2, Monongahela River

Sheet 8 of 10 sheets

1. Project: Rehabilitation of Lock & Dam No. 2, Monongahela River
2. Location: River wall Monolith R-23, 6.7' U.S. of R-24 Joint and 5.8' landward from river face
3. Drilling Agency: USAE-WES
4. Hole No.: BR WES R-5-86
5. Name of Driller: Dan Taylor
6. Direction of Hole: ☒ Vertical ☐ Inclined ____ deg. from vert.
7. Thickness of Overburden: 67.5' concrete
8. Depth Drilled into Rock: 23.2' shale
9. Total Depth of Hole: 90.7'
10. Size and Type of Bit: 6" X [illegible]"
11. Datum for Elevation Shown: MSL
12. Manufacturer's Designation of Drill: Failing Skid Rig
13. Total No. of Overburden Samples Taken: Disturbed ____ Undisturbed ____
14. Total Number Core Boxes: 32
15. Elevation Ground Water: ____
16. Date Hole: Started 18 Dec 85 Completed 24 Jan 86
17. Elevation Top of Hole: 730.5'
18. Total Core Recovery for Boring: Rock 99 %
19. Signature of Inspector: Scott Murrell

Elevation	Depth	Legend	Classification of Materials (Description)	% Core Recovery	Box or Sample No.	Remarks (Drilling time, water loss, depth of weathering, etc., if significant)
	70.0				25	
		MB	Calcareous inclusions.			
	71.0	MB				
	72.0	MB	Gray shale with calcareous inclusions, siliceous, slightly sandy, moderately hard.	98	26	Run: 13 Begin: 71.6', 72.1' End: 76.7' D.T.: 2 hr 18 min D. Press: 240 RPM: ≈100 Rec: 4.8' Loss: 0.1' Comments: Some fragments lost at breaks.
	73.0	MB				
		MB				
		MB				
	74.0					
	75.0	MB			27	Calcareous patches turned into seam down center of core.
	76.0					
		MB				
	77.0		Gray shale, slightly sandy, moderately hard, siliceous, with calcareous inclusions.			Run: 14 Begin: 76.7' End: 80.8' D.T.: 1 hr 55 min D. Press: 240 RPM: ≈100 Rec: 4.2' Loss: 0.1' Comments: Calcareous seam still present.
		MB				
	78.0			100	28	
		MB				
	79.0					
	80.0	MB				

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Project: Rehabilitation of Lock & Dam No. 2, Monongahela River

Hole No.: BR WES R-5-86

Hole No. BR WES R-5-86

DRILLING LOG	DIVISION Ohio River	INSTALLATION Monongahela River	SHEET 9 OF 10 SHEETS
1. PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River		10. SIZE AND TYPE OF BIT 6" X 7 3/4"	
2. LOCATION (Coordinates or Station) River Wall Monolith R-23, 6.7' U.S. of R-24 Joint and 5.8' landward from river face		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY USAE-WES		12. MANUFACTURER'S DESIGNATION OF DRILL Failing Skid Rig	
4. HOLE NO. (As shown on drawing title) and file number BR WES R-5-86		13A. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED	UNDISTURBED
5. NAME OF DRILLER Dan Taylor		14. TOTAL NUMBER CORE BOXES 32	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN 67.5' concrete		16. DATE HOLE STARTED 18 Dec 85	COMPLETED 24 Jan 86
8. DEPTH DRILLED INTO ROCK 23.2' shale		17. ELEVATION TOP OF HOLE 730.5'	
9. TOTAL DEPTH OF HOLE 90.7'		18. TOTAL CORE RECOVERY FOR BORING Rock 99 %	
		19. SIGNATURE OF INSPECTOR Scott Murrell	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	80.8	MB				
		MB				
	81.0		Gray shale, siliceous with calcareous inclusions, moderately hard, slightly sandy.		29	Run: 15 Begin: 80.8' End: 85.5' D.T.: 2 hr 23 min D. Press: 240 RPM: ≈100 Rec: 3.7' Loss: 1.0' Comments: Seam still present.
		MB		100		
	82.0					
		MB				
	83.0				30	
		MB				
	84.0					
		MB				
	85.0					Run: 16 Begin: 85.5' End: 89.6 D.T.: 2 hr 10 min D. Press: 240 RPM: ≈100 Rec: 4.7' Loss: 0.4' Comments: Seam still present.
			Healed fracture.			
		MB			31	
	86.0					
			Gray shale, moderately, hard, slightly sandy, siliceous with calcareous inclusions.			
		MB		100		
	87.0	MB				
		MB				
		MB				
	88.0					
					32	
	89.0	MB				
	90.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE (TRANSLUCENT)

PROJECT Rehabilitation of Lock & Dam No. 2, Monongahela River | HOLE NO. BR WES R-5-8

Hole No. BR WES R-5-86

DRILLING LOG

DIVISION: Ohio River

INSTALLATION: Lock & Dam No. 2, Monongahela River

SHEET 10 OF 10 SHEETS

1. PROJECT: Rehabilitation of Lock & Dam No. 2, Monongahela River

2. LOCATION (Coordinates or Station): R-23, 6.7' U.S. of R-24 Joint and 5.8' landward from river face

3. DRILLING AGENCY: USAE-WES

4. HOLE NO. (As shown on drawing title and file number): BR WES R-5-86

5. NAME OF DRILLER: Dan Taylor

6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.

7. THICKNESS OF OVERBURDEN: 67.5' concrete

8. DEPTH DRILLED INTO ROCK: 23.2' shale

9. TOTAL DEPTH OF HOLE: 90.7'

10. SIZE AND TYPE OF BIT: 6" X 3 7/8"

11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL

12. MANUFACTURER'S DESIGNATION OF DRILL: Failing Skid Rig

13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED: ; UNDISTURBED:

14. TOTAL NUMBER CORE BOXES: 22

15. ELEVATION GROUND WATER:

16. DATE HOLE: STARTED 13 Dec 85; COMPLETED 24 Jan 86

17. ELEVATION TOP OF HOLE: 730.5'

18. TOTAL CORE RECOVERY FOR BORING: ROCK 99 %

19. SIGNATURE OF INSPECTOR: Scott Murrell

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	90.0		Gray snale, siliceous with calcareous inclusions, moderately hard, slightly sandy E.O.B. @ 90.7'.	100		Run: 17 Begin: 89.6 End: 90.7 D.T.: ≅45 min D. Press: 240 RPM: ≅100 Rec: 1.5' Loss: --- Comments: Clutch broke on drill rig. Abandoned hole at 90.7' depth.

Abbreviations:
D.T.: Drill Time
D. Press: Drill Pressure
Rec: Recovery
E.O.B.: End of Boring
M.B.: Mechanical Break
N.B.: Natural Break
U.S.: Upstream

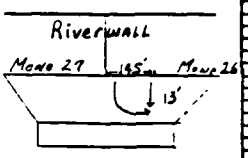
ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: Rehabilitation of Lock & Dam No. 2, Monongahela River

HOLE NO.: BR WES R-5-8

Hole No. -

DRILLING LOG	DIVISION: Ohio River	INSTALLATION: Lock & Dam 2	SHEET 1 OF 1 SHEETS
1. PROJECT: Rehab. of Lock & Dam 2, Mon. River	10. SIZE AND TYPE OF BIT: [illegible]		
2. LOCATION (Coordinates or Station): See Remarks	11. DATUM FOR ELEVATION SHOWN (USM or MSL): MSL		
3. DRILLING AGENCY: USAE-MRD	12. MANUFACTURER'S DESIGNATION OF DRILL: MCR-II, Series [illegible], 115 volt		
4. HOLE NO. (As shown on drawing title) and file number: BR WES R-6	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN:	DISTURBED: -	UNDISTURBED: 0
5. NAME OF DRILLER: Dan Taylor	14. TOTAL NUMBER CORE BOXES: 1		
6. DIRECTION OF HOLE: ☐ VERTICAL ☒ INCLINED See Remarks DEG. FROM VERT.	15. ELEVATION GROUND WATER: N/A		
7. THICKNESS OF OVERBURDEN: 0.0	16. DATE HOLE: STARTED 20 Oct 85	COMPLETED 20 Oct 85	
8. DEPTH DRILLED INTO ROCK: 3.3	17. ELEVATION TOP OF HOLE: 715.5		
9. TOTAL DEPTH OF HOLE: 3.3 ft. Concrete	18. TOTAL CORE RECOVERY FOR BORING: 100 %		
	19. SIGNATURE OF INSPECTOR: [signature]		

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	0.0		Surface Condition: moderately weathered with medium to severe scaling. Maximum exposed aggregate size is 2".			Run: 1 Begin: 0.0 End: 3.3 D.T.: 1 hr 55 min. Rec: 3.25' Remarks: Pulled off .05'. Drill action was smooth. 100% of water was retained.
	1.0					
			0.0 - 3.25 Concrete: gray, siliceous with some carbonates, maximum aggregate size is 3", river gravel, subrounded to subangular, good consolidation, entrapped air and entrained air, many voids generally less than ¼" diameter & deep.	100%	Box 1	ABBREVIATIONS: D.T: drill time Rec: recovery E.O.B: end of boring
	2.0					
	3.0			Run 1		LOCATION:
			E.O.B. = 3.3'			 ← River flow → Direction of Hole: Perpendicular to the surface.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: Rehab. of Lock & Dam 2, Mon. River | HOLE NO.: BR WES R-6

Hole No. BR WES R-7-86

DRILLING LOG

DIVISION: Ohio River

INSTALLATION: Locks & Dam No. 2, Mon River

SHEET 1 of 1 SHEETS

1. PROJECT: Rehabilitation of Locks and Dam No. 2, Monongahela River
2. LOCATION (Coordinates or Station): Lower Guard Wall, Monolith 29, 20 ft from U.S. joint, 3 ft from land face
3. DRILLING AGENCY: USAE WES
4. HOLE NO. (As shown on drawing title) and file number: BR WES R-7-86
5. NAME OF DRILLER: Dan Taylor
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: 0.0 ft
8. DEPTH DRILLED INTO ROCK: concrete 3.0 ft
9. TOTAL DEPTH OF HOLE: 3.0 ft
10. SIZE AND TYPE OF BIT: 6-in. thin wall
11. DATUM FOR ELEVATION SHOWN (MSL): MSL
12. MANUFACTURER'S DESIGNATION OF DRILL: Kor-It, Series K-100, 110 volts
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED: ; UNDISTURBED:
14. TOTAL NUMBER CORE BOXES:
15. ELEVATION GROUND WATER:
16. DATE HOLE: STARTED 15 Feb 86; COMPLETED 15 Feb 86
17. ELEVATION TOP OF HOLE: 724.5 ft
18. TOTAL CORE RECOVERY FOR BORING: 100 %
19. SIGNATURE OF INSPECTOR:

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Surface intact			
		MB	Concrete good, natural and crushed siliceous aggregate, maximum size 1-1/2 in.			
	1.0		1/2 in. rebar		Box 1	
			Has entrapped and entrained air	100		
	2.0	MB				
	3.0	MB				

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: Rehab of Lock & Dam 2, Mon. River

HOLE NO. BR WES R-7-86

APPENDIX C: PETROGRAPHIC REPORT, CONCRETE

Corps of Engineers, USAE Waterways Experiment Station	Concrete Report	Structures Laboratory P. O. Box 631 Vicksburg, Mississippi
Project Examination of Concrete, L/D #2 Monongahela River		Date 15 March 1988

Samples

1. Twenty-one cores were taken from the concrete at Locks and Dam No. 2 on the Monongahela River. One core was drilled into the backfill area beyond the concrete esplanade.

2. Nine of the cores were taken from horizontal holes. The remaining twelve cores were taken from vertical holes. Five of the vertical cores were drilled through concrete and into foundation rock. The cores are identified in Table 2 (with Cores Received Section).

Test procedures

3. All of the material from the twenty-one cores was examined in the field and again in the laboratory. The quality and condition of both the concrete and the foundation rock were noted. Representative samples of both material types were selected for more detailed examination and testing. Pieces of concrete that contained visible evidence of poorer-quality or significant reaction products were specifically chosen. The concrete samples examined in detail are identified below:

Field Id.	Orientation in Wall	Depth of Sample	Concrete Technology Division Serial No.
L-1	vertical	0.0- 3.15-ft	Pitts-13 CON-1
L-6	horizontal	1.2- 1.40-ft	Pitts-13 CON-12
L-7A	vertical	39.5-43.1-ft	Pitts-13 CON-29
M-1	vertical	32.6-35.75-ft	Pitts-13 CON-51
M-2	horizontal	0.0- 1.0-ft	Pitts-13 CON-60
M-5	horizontal	0.0- 3.3-ft	Pitts-13 CON-63
R-1	vertical	0.0- 1.65-ft	Pitts-13 CON-110
R-4	horizontal	0.0- 3.1-ft	Pitts-13 CON-112
R-5	vertical	31.0-33.2-ft	Pitts-13 CON-97

4. Samples for physical tests of the concrete were taken from both sound and poorer quality material. This was done to obtain the information on the "best case" and "worst case" material in order to ascertain just how bad the "bad" concrete was.

5. Samples from six of the cores were cut, ground smooth, and photographed. They were examined both visually and with the aid of a stereomicroscope.

6. The exterior surface of cores Pitts-13 CON-1, CON-60 and CON-112 were photographed.

7. A sawed slab from the top portion of sample Pitts-13 CON-112 was etched in dilute hydrochloric (HCℓ) acid to expose reaction rims present on some of the coarse aggregate. The etched surface was then examined both visually and with a stereomicroscope.

8. Cement paste concentrates were prepared from all six core samples. These were examined as tight-packed powder samples by X-ray diffraction (XRD).

9. Fine-grained white material was noted at the border of a piece of porous limestone coarse aggregate in sample Pitts-13 CON-112. The aggregate was located in a preexisting fracture surface. A small portion of the powder was collected and examined by XRD; the aggregate and surrounding paste were photographed.

10. Representative pieces of each coarse aggregate type were selected and examined by XRD.

11. Thin sections from four cores (Pitts-13 CON-1, CON-29, CON-60, and CON-112) were prepared and examined using a polarizing microscope. The thin sections were chosen from areas of the cores that represented typical concrete. Sections from cores Pitts-13 CON-60 and CON-112 contained coarse aggregate with rims.

12. All X-ray diffraction patterns were made using an X-ray diffractometer with nickel-filtered copper radiation.

Results

13. The concrete placed at the lower elevations in the three lock walls was easily distinguished from the concrete placed at the upper elevations. Aggregate used in the concrete at lower elevations was natural river sand and gravel with well rounded edges. Photograph C1 represents concrete placed at the lower elevations in all three walls. The natural river gravel was composed of coarse and fine-grained sandstone, siltstone, igneous and gneissic rock particles and some carbonate rock. Some of these particles were fractured, and several had either reaction or weathering rims. A few particles has siderite cores with a rim of geothite. The fine aggregate consisted of a

mixed composition. The mineral composition of eight typical coarse aggregates is shown in Table C1.

14. The concrete paste in the lower elevations of all three walls was a dark grayish color, except in areas where carbonation had occurred. The concrete is air-entrained and contains some entrapped air voids (voids >1 mm in diameter). No cracks were noted in the paste.

15. A general description of the concrete from the upper level each wall follows:

Land Wall Cores

16. The concrete placed at the upper elevations in the land wall (Pitts-13 CON-1, CON-5, CON-10, CON-12, and CON-29) was made using crushed limestone coarse aggregate and a natural, mixed composition fine aggregate. The coarse aggregate was a dense, dark colored material, consisting of calcite and trace amounts of clay (Table C1). No reaction rims were noted in this aggregate (Photograph C2).

17. The concrete paste in the upper elevations of the land wall was a dark grayish color, except for areas where carbonation had occurred (Photograph C2). It was air-entrained and contained some entrapped air. No cracks were noted. Photograph C3 shows the surface concrete condition at boring L-1 (Pitts-13 CON-1). The surface concrete of the other borings in the land wall was similar.

Middle and River Wall Cores

18. The concrete at the upper elevations of the middle and river walls was made using natural river gravel as coarse aggregate and a natural, mixed composition fine aggregate. The predominant rock type was dolomite, with some particles of igneous and metamorphic rock. The dolomite had well rounded edges, reaction rims (Photograph C4), and some weathering rims. Horizontal cores taken from above the upper pool level in both locks had good exterior surfaces; no cracking was noted. Hairline cracks in both paste and aggregate were present to a depth of approximately 0.4-ft in cores Pitts-13 CON-60, CON-110, and CON-112. Cores Pitts-13 CON-60 and CON-112 were taken from below the upper pool level on the land face of the middle wall and the land face of

the river wall, respectively. The exposed surfaces of these two cores were moderately weathered with exposed aggregate. Photograph C5 shows the condition of the Pitts-13 CON-112; CON-60 was similar.

19. The concrete paste in the upper elevations of the middle and river walls was a light gray color. Entrained and entrapped air were present. Concrete from boring M-1 (Pitts-13 CON-51) contained entrained air although it was reported in the field logs that it was not air-entrained.

20. The slab of concrete from core Pitts-13 CON-112 that was etched in dilute HCℓ showed that the rimmed areas on coarse dolomite aggregate dissolved at the same rate as the nonrimmed areas.

21. The paste concentrates of cores Pitts-13 CON-1, CON-29, CON-51, CON-60, CON-110, and CON-112 showed similar compositions by XRD. Calcium silicate hydrate (C-S-H), calcium hydroxide (CH), ettringite, and tetracalcium aluminate carbonate-11-hydrate (monocarboaluminate) phases of hydrated portland cement were present in each sample. Hydrogarnet was also identified in Pitts-13 CON-29. Unhydrated portland cement was detected by XRD in the paste concentrates, occurring as one or more of the calcium aluminoferrite solid solution series.

22. The white powder found around the coarse aggregate (Photograph C6) in sample Pitts-13 CON-112 contained calcium carbonate as three different minerals; calcite, aragonite, and vaterite. No other crystalline phases were identified in the powder.

23. Table C1 gives the mineralogical data for several coarse aggregates examined by XRD. The sandstones examined from concrete in lower elevations contained mainly quartz, feldspar, mica, and clays. One igneous particle also contained a monoclinic amphibole. The dark, dense, crushed limestone rock used in the upper elevations of the land wall was mainly calcite. A trace of clay mica was also present. The brownish coarse carbonate rock used in the upper elevations of the middle and river walls contained a large amount of dolomite. In every case but one, the carbonates (calcite and dolomite) were about equal in amount, or there was more dolomite. Clay was also present in these rocks.

24. The examination of petrographic thin sections made from four concrete samples showed both normal hydrated cement paste with C-S-H and CH present, and paste that was highly carbonated. The amount of CH present in the concrete was fairly high for areas that were not carbonated. Isotropic

material that was probably C-S-H gel was abundant in the paste. Unhydrated portland cement was identified in the thin sections as calcium silicates and calcium aluminoferrites. The sections made from samples Pitts-13 CON-60 and CON-112 showed coarse aggregate with euhedral and subhedral crystals of dolomite in a fine-grained calcite matrix. The section made from sample Pitts-13 CON-112 had a portion of the large aggregate seen in the lower center of Photograph C4. The rock has a reaction rim, but no visible damage or reaction product at the rock-paste interface was found in the thin section.

Discussion

25. In general, the concrete in the three lock walls appears to be in good condition and is competent. The damaged concrete is confined to the lock walls below the upper pool level, and this is minor.

26. The damaged areas are in the exposed ends of the horizontal cores taken from areas below the upper pool level in the locks. The damage consisted of etched surfaces, leaving aggregate exposed, and as hairline cracks normal to the direction of coring that extended to a depth of 0.4-ft. The etching is probably due to chemical action.

27. The XRD results of examination of paste concentrates and the examination of thin sections using a polarizing microscope showed that some carbonation of the paste had occurred. The extent of carbonation is minor, except in areas near the surface of lock walls where the carbonation occurs mainly as calcite. Some carbonation has occurred throughout the paste as indicated by the presence of monocarboaluminate. The resulting hairline cracks may be due to this carbonation of the paste causing carbonation shrinkage.

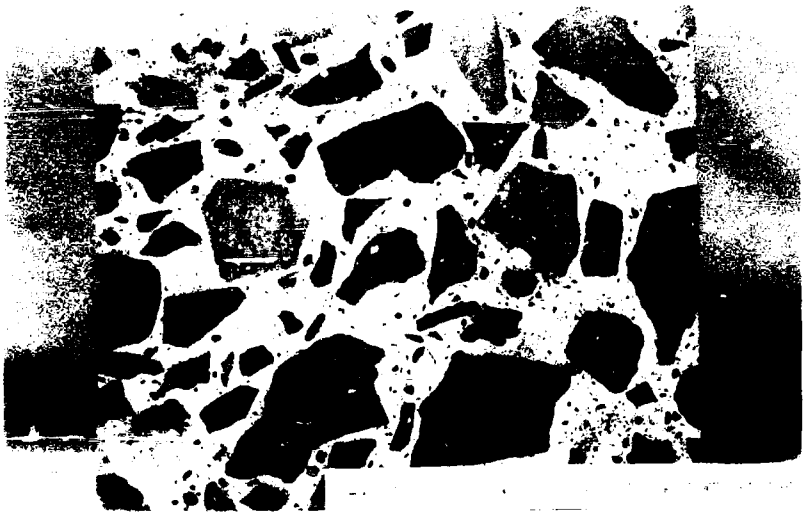
Table C1

Mineralogical Composition of Selected Coarse Aggregate from Locks No. 2 Concrete by X-ray Diffraction

	Sample Identification							
				Pitts-13 CON-				
	1	29	29	51	60	60	110	112
Minerals	Agg. 2	1	4	1	1	2	2	2
Clays								
Kaolinite	X	X					X	X
Clay-Mica	X	X		X	X	X		X
14A Material		X						
Nonclays								
Quartz	X	X		X		X	X	X
Feldspar		X						
Mica		X						
Calcite	X			X	X	X	X	X
Dolomite				X	X	X	X	X
Siderite			X					
Goethite			X					

PITTS -13 CON - 29

Photograph C1. Concrete from L-7A. The coarse aggregate is mainly coarse and fine-grained sandstone. The dark particle near the lower center has a rim of goethite and a core of siderite. The dark rims are mainly weathered rims. Some rims are reaction rims



Photograph C2. Concrete from L-1. The coarse aggregate is crushed limestone. No reaction rims are present

Photograph C3. Surface concrete at L-1. The surface concrete is in good condition

TTS-13 CON-112

Photograph C4. Concrete from R-4. Hairline cracks are through coarse aggregate and paste. Note the reaction rim around the aggregate at the bottom center. The texture of this aggregate is crystalline dolomite with a matrix of fine-grained calcite

PITTS -13 CON - 112

Photograph C5. Concrete from R-4. This shows the surface concrete in the lock walls. The surface has been etched. Coarse aggregate is exposed

Photograph C6. Concrete from R-4. Note the white powder around the coarse aggregate. The composition of the powder is calcite, aragonite, and vaterite

APPENDIX D: PETROGRAPHIC REPORT, RIVER SEDIMENTS AND FOUNDATION ROCK

Corps of Engineers, USAE Waterways Experiment Station	Petrographic Report	Structures Laboratory P. O. Box 631 Vicksburg, Mississippi
Project Examination of Rock from Locks and Dam No. 2, Monongahela River		Date 1 December 1986

Samples

1. Six cores were drilled into foundation material at the site; two of these cores were drilled through backfill material beyond the land wall. This material was received at the Structures Laboratory (SL) on 26 February 1986. Descriptions of the material received are shown below:

Field Location and Id.	CTD Id. No.	Sample Types
Land Wall Backfill BR WES L-2	Pitts-13 DC-1 to DC-18	Slag and gravel backfill. Blue-gray, brown, and gray shale; soft to mod. hard.
Land Wall Backfill BR WES L-5	Pitts-13 DC-19 to DC-33	Slag, steel, gravel, and clay backfill. Blue-gray, brown, and gray shale; soft to mod. hard.
Land Wall BR WES L-7A	Pitts-13 DC-34 to DC-53	Shale, gray and red, soft to mod. hard. Gray shale, silty, mod. hard to hard.
Middle Wall BR WES M-1	Pitts-13 DC-54 to DC-65	Gray shale, soft to mod. hard. Brown shale, soft to mod. hard. Red and gray shale, soft to mod. hard.
Middle Wall BR WES M-6	Pitts-13 DC-66 to DC-75	Gray shale, silty, mod. hard.
River Wall BR WES R-5	Pitts-13 DC-76 to DC-84	Gray shale, silty, mod. hard.

Samples representing three types of shale, distinguished by color, were selected for testing from the six cores.

Test Procedures

2. All of the cores were inspected in the laboratory, and hand samples were taken to verify field descriptions. Each sample was then inspected visually and with a stereomicroscope to determine physical characteristics.

3. A portion of each rock type sample was air dried, ground to pass a 45-μm (No. 325) sieve, and examined by X-ray diffraction (XRD).

4. Two sedimented slides of clay-sized material (<2 μm e.s.d.*) were made from the samples containing predominantly clay minerals. Both slides were examined by XRD following air drying. One slide was X-rayed again after saturation with glycerol. The remaining slide was heat treated at 350°C for one hour to dehydrate clay minerals and examined by XRD in a static nitrogen atmosphere in order to prevent rehydration of the clay minerals during examination.

5. An X-ray diffractometer with nickel-filtered copper radiation was used for all XRD work.

Results

6. Blue-gray shale. The sample consisted of bluish-gray (dusky blue-green, 5 BG 3/2) (The Rock Color Chart Committee 1975)** shale that was soft to moderately hard, moderately weathered, and very fine grained (<0.1 mm) (Headquarters, US Army Corps of Engineers (HQUSACE) 1975). The rock contained numerous healed horizontal fractures and an open vertical joint. Some areas contained calcareous nodules and iron staining. Major mineral constituents of the rock were quartz, plagioclase feldspar, and clays. The clay minerals present were kaolinite, clay-mica, chlorite, and vermiculite.

7. Brown shale. This sample consisted of a moderate brown (5 YR 3/4) (The Rock Color Chart Committee 1975) shale that was soft to moderately hard, slightly weathered, and very fine grained (<0.1 mm) (HQUSACE 1975). The rock contained numerous open horizontal fractures and occasional calcareous nodules. Major mineral constituents of the sample were quartz, plagioclase feldspar, and clays. The clay minerals identified were kaolinite, clay-mica, chlorite, and vermiculite.

8. Gray shale. By far the most abundant of the three rock types, this sample was an olive gray (5 Y 4/1) (The Rock Color Chart Committee 1975), silty, moderately hard to hard shale. It was slightly weathered and very fine grained (<0.1 mm) to fine grained (0.1-0.4 mm) (HQUSACE 1975).

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* Equivalent Spherical Diameter
** See References at the end of the main text.

It remained intact when submerged in water. The rock had some iron staining and contained numerous calcareous nodules. Major mineral constituents were quartz, plagioclase feldspar, and clay minerals. The clay minerals present were kaolinite, clay-mica, chlorite, and vermiculite.

9. The mineral composition of all three samples is shown in Table 1.

Table 1

Mineralogical Composition of Three Samples by X-Ray Diffraction

Constituents	Blue-Gray Shale	Brown Shale	Gray Shale
Quartz	X	X	X
Plag. Feldspar	X	X	X
Kaolinite	X	X	X
Clay-Mica*	X	X	X
Chlorite	X	X	X
Vermiculite	X	X	X

* Clay-sized mica.